SOMEBODY SHOULD DO SOMETHING ABOUT THIS!

A Teacher's Resource Book on Energy and the Environment

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A Teacher's Resource Book on Energy and the Environment

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* For additional **"Somebody Should DO Something About This"** resource guides, contact:

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OBJECTIVES:

This resource will provide teachers with:

1. background information on non-renewable energy sources, renewable energy sources, energy conservation and energy efficiency, and the environmental effects of resource use;

2. supplementary resources related to the content areas to help extend the learning; and

3. sample activities related to the content which they can implement in their classroom, school, jurisdiction, or community.

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INTRODUCTION

Everybody is talking about the environmental crisis today. It is being added to the school curriculum, grocery stores are urging us to "go green", and every newspaper, every day, has a new environmental story. Kids care about the environment, and we have to keep them caring. This resource guide is to help you make some sense of these current environmental issues so that you can help your students understand them, to provide you with supplementary resources you can use to add to almost any curriculum area, and activities which can be used in the classroom, school, jurisdiction, or community.

Ask anyone on the street about environmental problems, and they will agree; Somebody Should Do Something About This! This resource guide will help you to fill in the "Somebody" and "Something" with more specific words:

Who is the Somebody?

What is the Something?

Who is Somebody?

Who should take the lead - government? industry? consumers? It is easy to demand that government do something about this, but you will find that they already are. Who can convince them to do more?

What is Something?

Programs? Prosecuting polluters? Stop driving cars? Building energy efficient homes? Mandatory environmental education? Probably any or all of these things would all help our environmental crisis. This resource guide will give you more ideas for possible, practical strategies.

Maybe this quotation answers both questions.

> *"Nobody made a greater mistake than he who did nothing because he could do only a little."*
>
> - Edmund Burke

Get your staff and students involved. The activities described in this book are adaptable for all ages and grade levels, and for urban or rural settings.

Wendy Palynchuk

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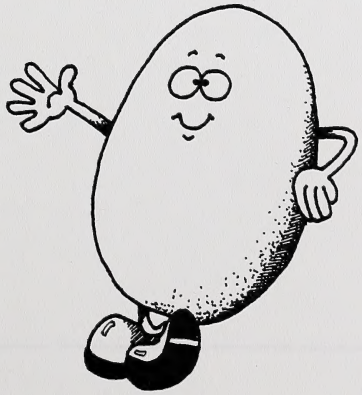


1. ACTIVITIES

If we were less dependent on non-renewable energy sources, our water supply would be healthier. Especially if you can adopt a stream in your area, this activity is ideal for teaching students responsibility for the environment.

Objectives To have the school take responsibility for the care and protection of a stream in Alberta.

Time Ongoing

Materials Supplementary Resources - Teaching Resources List

Procedure

1. Check the Supplementary Resources section under Teaching Resources for the Adopt-a-Stream program available from FEESA (Friends of Environmental Education Society of Alberta).
2. Order the Adopt-a-Stream kit from FEESA, and follow directions for implementation.
3. This resource will begin its pilot phase in November 1990, and will be available provincially in the spring of 1991. ◆

CAR CARE CLINIC
Activity Two

Instead of the usual "car wash", try this fundraising idea - and promote energy conservation and efficiency at the same time!

Objectives

To make students aware of ways that an automobile's energy consumption can be reduced.

To spread this awareness to members of the community.

Time

Preparation - 1 hour
Clinic - 1 day

Materials

Transportation booklets from Alberta Energy,
Energy Efficiency Branch
Tire gauge
Materials for making signs

Procedure

1. Obtain free transportation conservation booklets from:

   Transportation Section
   Alberta Energy Efficiency Branch
   2nd floor, 10010 - 106 Street
   Edmonton, Alberta T5J 3L8
   427-5200

2. Choose a day for the car care clinic to take place, and obtain permission to hold it at that time, and that location. A logical location may be a nearby filling station, an automotive supply store, or the school parking lot.

3. Write up a news release including the school's name, a description of the event, a contact name and telephone number, and location, date and time. Send to the media to help promote your event.

4. Identify student volunteers from every class, or perhaps a school club, team, or the grad or student's council would be interested in staffing the clinic and raising funds for their projects.

5. Meet with the student volunteers. Distribute the transportation booklets, and outline some ways to increase vehicle fuel efficiency. Describe their duties at the Car Clinic.

6. Ask students to make promotional signs, and a sign listing items which will be checked, so that customers and volunteers can refer to it.

7. Set an appropriate price for the clinic - perhaps a "loonie" ($1.00) per car.

8. Obtain all the materials required in advance of the clinic date.

9. Check the tire pressure of all tires, and let the drivers know if they are too low. Proper inflation will extend the life of the tires, and save gasoline - up to 5%. If you are at a filling station, automotive parts store or new car dealership, ask if you may use the air hose for the day to properly inflate tires.

10. Check the trunk and back seats, to make sure that the owner is not carrying around too much extra weight. A lighter car uses less gas.

11. Ask drivers when their last tune-up was, and if they have had their oil and fuel filters changed recently. Clean, tuned cars use less gas and produce fewer emissions, which contribute to acid rain, ozone smog, and the depletion of the ozone layer. Used motor oil can be recycled - find out about the Oil Drop Program by calling the Recycling Branch of Alberta Environment at 427-5838 in Edmonton.

12. Remind drivers not to let their cars idle unnecessarily - it takes less gasoline to start a car than it does to let it idle. Idling becomes less efficient than re-starting after about one minute of idling.

13. Ask drivers how they dispose of old car batteries - encourage them to have them recycled. Contact an automobile dealership, filling station or automotive parts store for information. ♦

CHRISTMAS CONCERT
Activity Three

Add the energy/environment message to your annual Christmas concert - parents and families are a captive audience - an ideal way to share information.

Objectives To spread energy/environment messages to the community at the school Christmas concert.

Time 1 hour

Materials Reused/recycled paper

Procedure

1. Save wasted paper from photocopying or duplicating that can be reused to print the program on - be sure to include a sentence stating that you have used recycled paper to protect the environment.

2. Generate a list of energy conservation and environmental tips which you can include in the program, post on a sign, or read out during the concert. Possible tips include:

   - place outdoor Christmas lights on a timer
   - use low-wattage Christmas lights
   - use a reusable artificial Christmas tree instead of a real one
   - save on giftwrap by reusing last year's, making cloth-wrapped reusable giftboxes or bags for family members (just like the stocking idea, only bigger!), or using creative solutions - coloured comics section of the newspaper, glossy magazine pages, etc.
   - if you have a fireplace, make an insert to seal it off and save heat when it is not being used
   - make gifts and tree ornaments instead of buying them
   - give unwanted items to a Christmas charity
   - compost leftovers or feed to birds
   - if away at Christmas, place lights on timers and turn down the thermostats on the furnace and hot water tank

3. Add some tips to the program before it is printed, or write up a poster to display prominently at the concert. ◆

Show students that something **can** *be done, that reycling paper is easy to do. They may feel empowered, and go on to bigger and better things, for protecting our environment and conserving energy.*

Objectives

To encourage students to reduce paper waste in the classroom.

To make students aware of the energy required to make paper, and the benefits of recycling.

Time

30 minutes

Materials

Cardboard box or other container
Paper for label

Procedure

1. Announce to students that you wish to start recycling paper in the classroom. After one side of a piece of paper has been used, it should be placed in the recycling box for reuse, for scratch paper or art projects. Read to them some of the following facts, or other items from Chapters 1 or 3:

   - paper accounts for 50% of all garbage
   - using recycled paper for making new paper requires 50% less energy than making paper from new pulp
   - recycling one tonne of paper replaces and preserves 17 trees, or approximately one acre of harvestable trees
   - recycled paper can be used to make new paper, roofing shingles, drywall, insulation, egg cartons, plant pots, tissue paper, animal bedding (instead of straw), packaging products (for pizza & potato chip boxes)
   - each tonne of recycled high-grade paper used for making new paper saves 4200 kilowatt-hours (kWh) of electricity

2. Ask students to make a label for the recycling box, on a piece of **reused** paper.

3. Attach the label to the outside of the box. Encourage other classrooms to make paper recycling boxes.

4. Research paper recycling in your area (contact the Recycling Branch of Alberta Environment - see Supplementary Resources section for address and phone number) so that you may have your collected paper recycled after it has been completely used.

5. Make sure the office and library get involved, too! While they're at it, they may want to consider using mechanical pencils instead of wooden ones, refillable pens instead of disposable ones, refillable tape dispensers instead of disposable plastic ones, and water-based instead of solvent-based markers. ◆

COMPOSTING
Activity Five

With landfill sites overflowing and the rising cost of waste disposal, it makes sense to reduce our waste output. Composting produces a natural fertilizer - a good alternative to petrochemical products which are made from non-renewable energy sources, and can pollute water sources. Try to get your school interested in this project - it will tangibly show them the benefits of recycling and energy conservation.

Objectives

To start composting at the school.

To make students aware of the advantages of composting, waste reduction and energy conservation.

To use the compost as fertilizer at the school or to be sold or donated to community organizations.

Time

2 hours preparation; a few minutes every 2 weeks thereafter

Materials

Organic waste
Eggshells, sawdust, cardboard (optional)
Container - used garbage can, barrel, or wooden box

Procedure

1. Determine if you can collect enough organic waste to make a compost pile worthwhile. Sources are cafeteria and lunchroom wastes, and any organic waste which staff and students wish to bring from home. You may also be able to obtain wastes from restaurants or institutions - they will probably be happy to get rid of it, if you pick it up.
2. If you will obtain wastes from restaurants or institutions, determine a method of collection - is it close enough for students to walk to, and bring back small bags? Would a teacher or parent volunteer have to collect it in a car or truck and deliver it to the school?
3. Once you have decided to start a compost pile, inform students of the benefits - that it will reduce the waste sent to already overcrowded landfill sites, and can be used for natural fertilizer instead of petrochemical fertilizer made from non-renewables.
4. Obtain suitable container(s) - options include an old garbage can, steel drum, wooden barrel or box. Remove the bottom of the container, and punch holes in the side for ventilation. Choose an appropriate location - not too near the school, or perhaps near where garbage is stored.

5. Throw in any organic wastes such as fruit and vegetable peelings, food leftovers, coffee grounds, straw and hay, grass, garden clippings and leaves. You may also use limited quantities of eggshells, sawdust and cardboard. Mix with soil, and some moisture. Alternate wet and dry layers in thicknesses between 7 and 15 cm.

6. For the first 4 weeks, leave it covered and undisturbed. Thereafter, uncover and mix it up every 2 or 3 weeks, as air is necessary to the composting process. If the weather has been very dry, add some water. If it is very rainy, cover the pile occasionally. If the compost gets soggy-looking, turn it more often and add absorbent material such as cardboard or sawdust. Cover it in winter to prevent heat loss.

7. Outdoors, the compost can be used on flower beds, vegetable gardens, and around trees and shrubs.

8. To use indoors on house plants, strain the compost first and bake it in an old pan for 2 hours at 200 ^{0}F to kill any weeds and insects.

9. Once you have determined how much compost you will be making, decide if you will use it only to cover the needs of the school, or if you will donate it to a local organization, or sell it to community residents to raise funds for environmental projects. ◆

DECORATIVE BANNERS
Activity Six

Many schools create banners to hang around the school or gymnasium, in the school's colours with a mascot or slogan - why not add a global message about caring for our planet?

Objectives

Make students more aware of energy and environment issues.

Have students help make banners with energy and environmental themes to be hung throughout the school.

Time

Preparation - 1 hour
Making banners - variable, approximately 4 hours each

Materials

Fabric (may include felt, burlap, parachute nylon, or any remnants)
Thread, needles
Glue
Assorted trimmings - these can include lace, cord, buttons - or any found objects which can be attached to the banner fabric - use your imagination!
Scissors
Wooden dowels
Fishing line
Eye screws

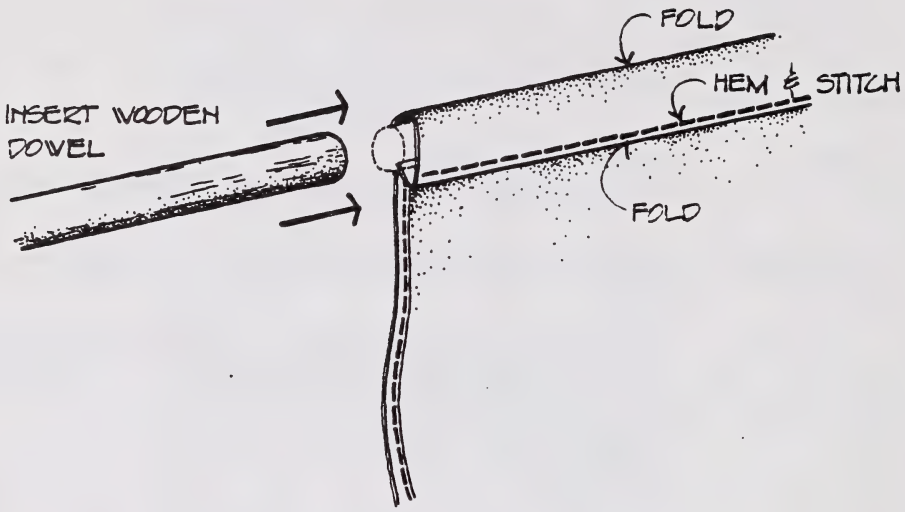
Procedure

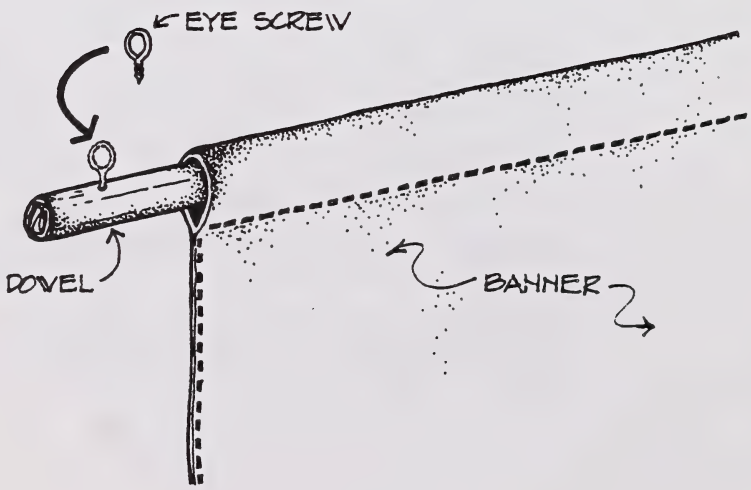
1. If you want to limit size and shape of banners, determine the dimensions ahead of time.
2. Ask students to bring in any of the materials they can. For other materials, see what the school can supply, if you have any budget available for purchase, or if a nearby hardware store will donate or give you a discount on materials. Check the Supplementary Resources listing of Classroom Material Suppliers for the phone number and address of Imagination Market - they can supply you with materials at a very low price, and they also offer workshops.
3. The banner workshops could take place over several noon hours, with teachers taking turns supervising and assisting.
4. Before beginning to decorate the banner, fold over 15 mm on both ends and hem. Then fold over 50 mm at one end and stitch, forming a rod pocket for the wooden dowel.

5. Decorate the banners by sewing or gluing on trimmings.

6. Iron or steam the banners before hanging.

7. When banners are complete, insert a wooden dowel in the rod pocket. Attach two eye screws to the dowel, as shown in the diagram. Take two lengths of fishing line and secure one to each of the eyes, for hanging. ♦





Kids love music - and they may enjoy this project, setting new words to old standards, or composing new songs. How about an "Energy Savers Rap" song?

Objectives

To have students set energy themes to music.

To have students teach their songs to other students, and perform for staff and others.

Time

2 hours

Materials

Musical notation paper (see next page)
Tape recorder
Blank cassette tapes (can you tape over old ones?)

Procedure

1. Encourage music teachers to become involved.
2. If you wish to have the students perform their songs for an audience, consider who the audience will be - the entire school, at an assembly? a school concert? at parent-teacher interview night?
3. If students need some ideas for songs, suggest they can set new lyrics to popular songs or old standards, or give them topic ideas, e.g., saving electricity, saving water, etc.
4. Depending on the ability of students, they may be able to write their song out in musical notation; if not, you may have to help. In this case, you may find it helpful to tape the songs.
5. You may also wish to duplicate copies of the lyrics, so that others may join in, sing-along style. ♦

MUSICAL NOTATION PAPER

They're not new - your mother or grandmother probably rolled up a blanket or towel and stuffed it under the door to prevent cold drafts from getting in. Students can make their own decorated "Draftenders" to take home, to use at school, or sell to raise money. It's an easy way for students to help save heat (and natural gas!), and protect the environment.

Objectives

To give students an opportunity to reduce the energy used for heating at home or school.

To make draft stoppers to place at the bottom of doors.

Time

2 hours

Materials

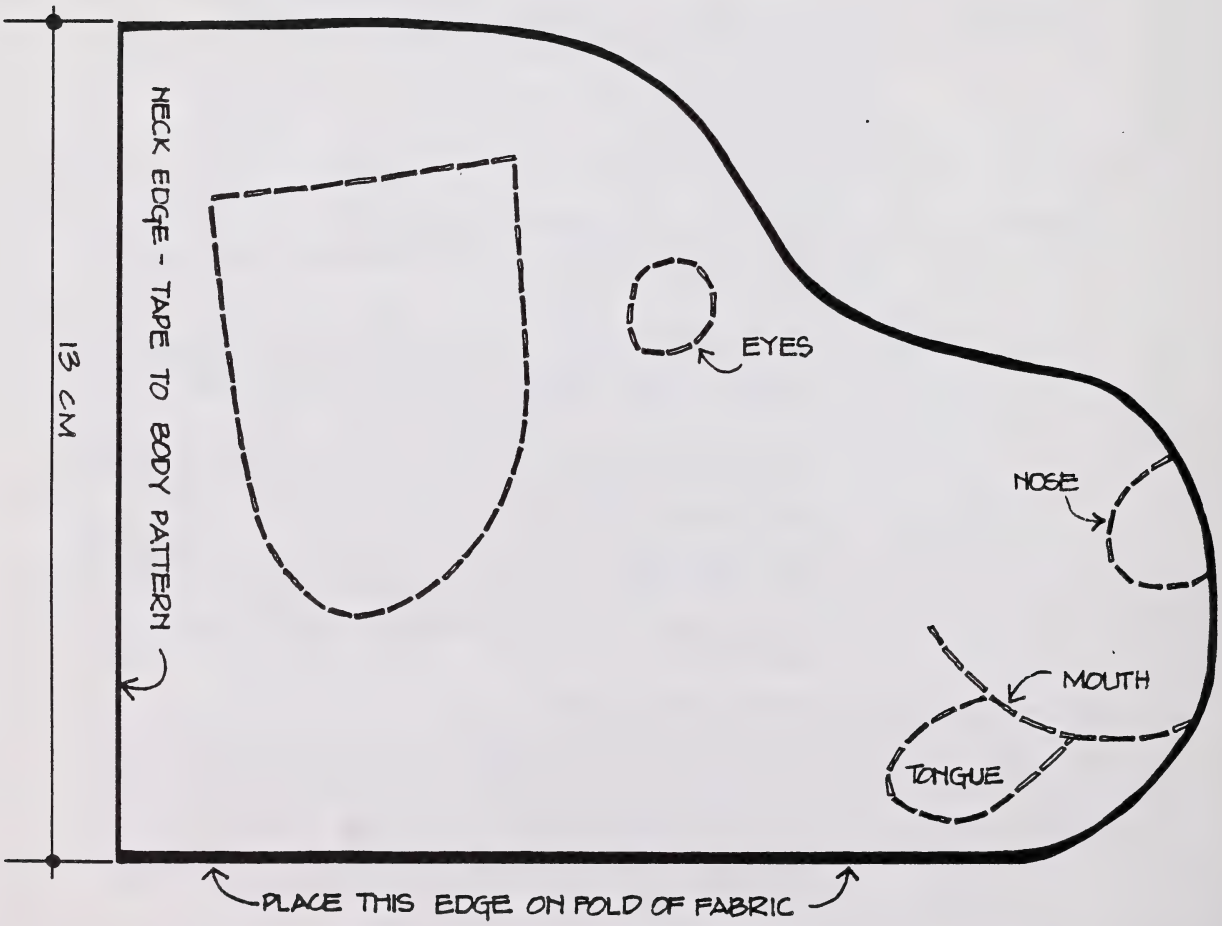
"Draftender" pattern - attached
Fabric remnant, approx. 26 cm by 90 cm
Thread, needles
Stuffing - e.g. beads, rice, panti-hose
Buttons
Trim - e.g. ribbon, cord, etc.

Procedure

1. Decide if you will make the draftenders for home or for school (this will affect the size, as school doorways are wider than residential doorways).
2. Cut out the head pattern (attached), and cut out a piece for the body, measuring 13 cm wide by 90 cm long (for home-size) or 1200 cm long (for school-size). Tape the body piece to the head piece at the neck where indicated.
3. Assist students in pinning the pattern piece to the fabric and cutting it out. Cutting and stitching can be decreased if the bottom edge of the pattern is placed on a fold.
4. Fold fabric right sides together, and sew a seam all around the head and body, leaving one end open for stuffing.
5. Fill the head and body with stuffing. It is not necessary to pack it full.
6. Sew up the end by hand.
7. Attach any trimming desired - buttons can be used for eyes, and trim could make a collar. Ears could be cut out of felt and attached to the head as shown. A nose, mouth, and tongue could be embroidered on.
8. This may be a good item to have students make and sell at a school bazaar. ♦

DRAFTENDER HEAD PATTERN

1. Cut out the head pattern.
2. Cut out a piece of paper 13 cm wide by 90 cm long (home-sized) or 1200 cm long (school-sized) and tape to the head pattern at the neck, as indicated.
3. Note markings for attaching eyes, ears, and nose.



DRAMA PROJECT
Activity Nine

Use a drama club or drama class to help promote your school's commitment to energy conservation and the environment. Have them write and perform a play for the rest of the school to spread the message!

Objectives

To present energy/environmental issues in an alternate format.

To increase students' knowledge of energy and the environment.

Time

Preparation - several weeks
Performance - approximately one hour

Materials

Reference Material
Props, set and costumes - will depend on the project

Procedure

1. Speak to the teacher in charge of the drama department or club. Suggest they choose energy and environmental issues as the theme for their next performance, for the school or the community.
2. If they require background information, ask them to read the Reference Material or act as a consultant to them yourself.
3. For sets and costumes, suggest that they use reused materials or costumes as much as possible. The Imagination Market can provide such materials at a very low price to school groups, and will even give school workshops. Check the Supplementary Resources, Classroom Material Suppliers list for their phone number and address. ♦

To be committed to energy conservation and the environment, one must be committed to the health of our planet. If every student sees a picture of the Earth every day, perhaps they will be more mindful of the human impact on our Earth's delicate ecosystem.

Objectives

To make posters of the earth to place in every classroom.

To make students more aware of the impact of energy use on the planet.

Time

2 hours

Materials

Reference Material
Paper (reused!)
Art media (may include paints, felt markers, pencil crayons, fabric scraps, glue, glitter, etc.)

Procedure

1. Select portions of Chapter 3, and perhaps Chapter 1, of the Reference Material to read to your students to make them aware of what energy use does to the environment.
2. Inform students that you want them to co-operate on making a poster of the planet to hang in the classroom, so that every time they look at it, they will be more thoughtful of their energy habits, and how they impact on the environment.
3. You may wish to limit the use of materials and provide only certain items to your students, or you may ask them to supply their own materials. Try to encourage the use of reused materials. As the paper will be covered, and hanging against a wall, paper which has already been used is appropriate.
4. Encourage every classroom to get involved. You may wish to have a competition, and have the best poster displayed in a visible place, such as the office or library. ♦

EARTHDAY BIRTHDAY
Activity Eleven

The Earth and her resources are precious gifts given to us, to take care of for our children. If more people had a feeling of respect for our planet, we would not now be facing an environmental crisis. Help students develop this respect, to take a role as stewards of the earth.

Objectives To have students demonstrate their respect for the earth by honouring it on Earth Day.

Time 3 hours

Materials
Birthday cake
Beverages
Reused paper and other found items for invitations, decorations and party hats
Plates, glasses, cutlery (pay for rental or for someone to come in and wash, rather than paying for disposable goods)

Procedure

1. Find out the date of Earth Day, held every April - check the Supplementary Resources section under Special Events for a contact.
2. Choose an appropriate location for the birthday party. Check its suitability with administration and custodial staff.
3. Determine who will be invited to the birthday party - students and staff only? Parents? School division staff?
4. Have a class or classes make invitations out of reused materials, and distribute a week ahead of time.
5. During the week prior to Earth Day, make announcements every day, giving students some information on energy use.
6. Have all duties completed the day before the event. These can be divided among classes - a junior or senior high home economics class can make a cake, elementary classes can make decorations, the school band or drama club can provide entertainment, a business practices class could obtain plates, napkins, and glasses which can be reused.
7. The day before the event, set up chairs, tables, etc. Make two classes responsible for clean-up - washing dishes, plates and napkins. ♦

ENERGY AUDIT
Activity Twelve

An energy audit can determine where energy is used in the school and what steps can be taken to improve energy efficiency and reduce operating costs. Alberta's Energy Bus is a mobile energy audit service operated by the Department of Energy mainly for business and industry. The Energy Bus will also audit school buildings - at no charge.

Objectives

To increase awareness of the importance of energy in operating the school.

To determine the potential to improve energy efficiency and reduce costs.

To involve all staff in energy management.

Time

Preparation - approximately 3 hours to complete questionnaire
Audit - 3 hours to tour school with technical staff
- 1 hour for presentation of audit findings.

Materials

Completed program questionnaire

Procedure

1. Contact the Energy Efficiency Branch and ask for a visit by the Energy Bus. Program information will then be sent to the school.
2. Complete program questionnaire and send to the Branch.
3. Audit will be scheduled and school notified.
4. When the Energy Bus arrives, the technical crew will use instruments to measure the efficiency of the building's energy systems.
5. At the end of the audit, a brief presentation will be made and a printed report given to the school. A letter will then be sent to the school summarizing the audit findings.
6. For more information, contact:

   Alberta Energy Efficiency Branch
   2nd floor, 10010 - 106 Street
   Edmonton, Alberta
   T5J 3L8
   427-5200

♦

Your students will be able to make informed energy decisions if they have the facts. Challenge students to learn about energy sources on their own, and to devise a creative way to tell others.

Objectives

To increase students' knowledge of energy sources, both renewable and non-renewable.

To encourage peer-assisted learning - students will be responsible for learning about a particular energy source, and for spreading that information to other groups.

Time

3 hours

Materials

Reference Material - Chapters 1 & 2
Camera and film

Procedure

1. Decide how you will divide up areas: will you have every class choose their own energy topic, or will you assign them? You may wish to divide it up by grade, class, or division. Suggested topics: non-renewable energy sources (coal, oil, natural gas); renewable energy sources (solar, wind, wood, water, geothermal, biomass); energy conservation, or the environmental effects of energy use.
2. Choose the culmination date - you may wish to have this coincide with a special event such as a school assembly or parents' night, so that classes can share their knowledge with others.
3. Speak to all teachers, get their input on the types of projects allowed (e.g., stories, plays, mime, poetry, songs, "rap", posters, display, etc.). Arrange for a volunteer, either a staff member or a parent, to photograph all projects on the day of the event.
4. Ask the principal to encourage participation by including information in the daily announcements.
5. On the day of the event, have one representative from each group briefly explain their topic and presentation.

6. This would be a good project for getting media attention - contact them a week to ten days before the presentation date, and ask if they would like to be present. Give them a news release including all relevant information, such as the school name, a description of the project, contact name and telephone number, and the date, time, and location of the event.

7. This project could be adapted for community outreach - consider presenting at a senior citizen's home, or children's hospital. ♦

Encourage every teacher in your school to incorporate energy and the environment into their curriculum. It's too important a topic to ignore - after all, the future of our planet is at stake.

Objectives

To expose teachers to educational materials on energy and the environment.

To encourage teachers to incorporate energy and environmental topics into their classroom curriculum plans.

Materials

Supplementary Resources - Teaching Resources section

Procedure

1. Review the Supplementary Resources section, especially the Teaching Resources list.
2. You may wish to copy a list for each teacher.
3. At a staff meeting, make all teachers aware of the many resources available. Many are free, or low cost. There are enough different materials available that every teacher can work on a different topic or kit. Encourage teachers to order materials. You may be able to co-ordinate the ordering. ◆

ENERGY IN THE NEWS
Activity Fifteen

Energy and the environment are getting a lot of attention in the media these days. Encourage students and staff to save newspaper and magazine articles for display at the school.

Objectives

To make students aware of current issues in the energy and environment fields.

To encourage students to take an interest in current events.

Time

A few minutes daily

Materials

Tape, glue, pins or thumb tacks
Bulletin board or construction paper

Procedure

1. Ask teachers to encourage students to bring to school newspaper or magazine clippings on energy and the environment, including editorial cartoons, comic strips, and advertisements of items which use or conserve energy.
2. Obtain permission to use a wall or bulletin board for displaying clippings.
3. You may wish to put up a background of coloured construction paper.
4. Use tape, glue, pins or thumb tacks, whichever is most appropriate. Use an "environmentally friendly" product!
5. Have students bring clippings to their teacher, who will in turn give them to you, to post. You may or may not wish to reject duplicated items.
6. Encourage staff and students to spend a few minutes every week viewing the current events display to keep up to date. ◆

ENERGY RADIO
Activity Sixteen

If your school has regular announcements, or plays music over the intercom at lunch hours, why not have an energy and environment focus? It will keep these topics in everyone's mind.

Objectives

To make students and staff aware of energy and environment facts.

To expose students to songs with an environmental message.

To encourage the reading of energy and environment tips over the intercom.

Time

Daily - 1 minute

Material

Reference Material

Procedure

1. Speak to the individual in charge of in-school announcements or radio, telling them of your idea. Tell them you can make tips available to them, or a list of energy and environment activities in the school and/or area.
2. Look for songs which have an environmental theme - you may also be able to get help on this from the person who works on your school radio station, or a local rock station. Some of the artists who have written and/or recorded such songs or shown their support for the environment include Madonna, Bruce Cockburn, Sting, Iggy Pop, Joni Mitchell, Ringo Starr, Peter Gabriel, U2, the Eurythmics, Midnight Oil, Gentlemen Without Weapons, Paul McCartney, Michael Jackson, Bryan Adams, Dead Kennedys, Spirit of the West, Lou Reed, 10,000 Maniacs, The Dead Milkmen, The B52s, and L'Etranger.
3. If you will provide a list of tips and activities, go through the Reference Material and find appropriate information. Or, you may copy the Reference Material and give it to the person making announcements, if they wish to formulate the list of tips themselves. ◆

ENERGY THEME DAYS
Activity Seventeen

Many schools have Hat Day or Greaser Day; what about Energy Saving Day? Use some of these ideas to show students (and staff) how they can incorporate energy conservation into their daily lives easily.

Objectives

To have special theme days incorporating energy conserving behaviours.

To make students and staff aware of how easily energy conservation can become part of their daily life.

Time

Preparation - 1 hour

Materials

Reference Material
Markers (water soluble)
Used paper

Procedure

1. After reading through the Reference Material, consider what topic you could choose for a theme day. These could include:

   Sweater Day (turn down the heat)
   Gasless Day (teachers car pool or take the bus, students ride bikes or walk instead of going in a car)
   Dark Ages Day (work without lights as much as possible)
   Cool Day (open windows and doors instead of using fans or air conditioners)
   Watch Your Waste Day (collect all paper to be reused or recycled, collect beverage containers for recycling, etc. - see how little garbage you can produce in one day)

2. Make posters and announcements to publicize the event. Ask students and staff to think of their own ways of saving energy. Ask teachers to devote a few minutes of class time first thing in the morning of the theme day for students to inform the rest of the class how they are saving energy.

3. Consider having an energy theme day once a month, or for several weeks in a row, to keep the message in students' and staff's minds. ♦

ENERGY TIP MOBILES
Activity Eighteen

Keep energy conservation alive in your school all year round, by making colourful mobiles to hang throughout the halls, in the library, classrooms, and other spaces. Students will see them every day, and will have pride in their own contribution to the effort.

Objectives

To challenge students to come up with energy conservation or environmental tips.

To have students make mobiles to decorate the school.

Time

Preparation - 1 hour
Hanging - 2 hours

Materials

Construction paper
Felt-tip markers (water soluble)
Fishing line
Scissors
Tape

Procedure

1. Choose a shape or shapes for mobile pieces. You may want to consider energy or environment-related shapes, such as a circle, sun, cloud, oil drop, tree, etc.
2. Make patterns for the mobile pieces. They should be large enough for students to be able to write clearly on them, and so they are legible once hanging up. Suggestion - 20 cm x 20 cm.
3. Help students choose energy-saving or environmental messages to put on their mobiles. Encourage them to use short messages, and to use lots of colour.
4. Let students choose the pattern piece they prefer, then decorate it and write on a slogan.
5. Tape a piece of fishing line to one end of the pattern piece. Mobile pieces may be hung singly or attached to a supporting cross-bar, made out of a coat-hanger, wooden dowel, or stiff cardboard. ♦

ENVIRONMENT CLUB
Activity Nineteen

Many schools are starting up student environment clubs. Gauge the interest at your school, and volunteer a few minutes a week to help them meet their goals.

Objectives

To assist students in organizing an environment club.

To encourage empowerment and responsibility in students.

Time

Preparation - 1 hour
Weekly - 30 minutes

Materials

Supplementary Resources listing
Reference Material

Procedure

1. Make an announcement, or post a notice that you will help students start an environment club. Arrange the date, time and place for the first meeting.
2. Choose an appropriate meeting time - recess? lunch hour? after school?
3. At the first meeting, inform students of the weekly meeting place and time. Ask students to clarify their goals - do they wish to help the school save energy, or to change their habits and those of their families and friends? Will they make information available, invite in guest speakers, order publications, obtain information for themselves?
4. Encourage students to read the Reference Material or other resources to better inform themselves on energy and environmental issues.
5. Assist students in obtaining resources by familiarizing them with the Supplementary Resources section.
6. Visit meetings for a few minutes every week to answer questions, keep the group on track, and provide assistance. ♦

ESSAY CONTEST
Activity Twenty

Many schools hold essay contests every year. What better topic than energy and the environment? Students are interested in it, and the more informed they are now, the more responsible energy consumers they will be.

Objectives

To increase students' awareness of energy and environmental issues.

To improve students' essay-writing skills.

Time

Preparation: 60 minutes
Contest: 2 weeks

Materials

Paper for posters

Procedure

1. Define dates of contest, including when it will be announced and when essays are due. Also decide where students will hand in their essays - perhaps a box in the office. Enlist the help of a judging board, which may include parents, other teachers, or school jurisdiction personnel.
2. Define contest parameters, including categories (by age? by grade?), length of essay (will this vary by category?), whether to be double-spaced, typed, or handwritten, and prizes, if any. You may be able to get small prizes donated by local businesses such as bookstores or stationery stores. Decide on a topic or choice of topics. These may include:

   - Recycling - How Does it Protect the Environment?
   - What Can Families Do to Save Energy?
3. Prepare a list of contest rules, duplicate and distribute to teachers. Also post on bulletin boards around the school, including the library, office, staffroom, etc.
4. Enlist the principal's assistance in promoting the contest by making announcements during the contest period, encouraging participation of students and teachers.
5. On the due date, divide up the essays among the judging board. Discuss with your judges how marks will be allotted, for example, how many points are deducted for misspelled words and grammatical errors.
6. Choose the winner(s), announce their names over the intercom, and present a certificate to them at a school assembly. ◆

FIELD TRIPS
Activity Twenty-One

Field trips can be a very effective teaching tool. There are many sites related to energy use and the environment which have school programs and can provide you with resources.

Objectives

To make students aware of the many businesses, industries, and government and private agencies which are involved in energy and the environment.

To expose students to different careers in the energy and environment field.

Time

2 hours preparation
Field trip - 1/2 - full day

Materials

Supplementary Resources section - Field Trip Centres

Procedure

1. Determine if your school has an adequate field trip budget and identify possible dates for the trip.
2. Check the Field Trip Centres listing in the Supplementary Resources section, and determine a location near you, and one that fits in with your school's curriculum. If you do not find anything appropriate, consider other centres - is there a landfill in your area? A recycling plant? A power plant, or oil company? Contact the organization, asking about any costs, and checking dates.
3. Determine logistics: How far away is the field trip site - will you have to go by bus? Will parents drive, or will students be able to walk or bike to the site? If travelling over a meal hour, will bag lunches be required? Will students need special clothing, equipment, or notebooks and pens?
4. Once you have identified a date for the visit, prepare a parent/guardian permission form, photocopy, and send home with the students. On the form, ask for parent volunteers to drive or chaperon.
5. Prepare a list of questions which students must answer and turn in after the field trip, to ensure learning.

6. The day of the visit, brief parent volunteers prior to setting out. Students who have not returned signed permission forms or who have come inadequately prepared should be left behind, especially for legal reasons.

7. Have students turn in their assignments, grade them, and return.

8. Follow up with the organization, giving them student feedback, curriculum fit, and suggested improvements. These organizations would also appreciate a letter from you or your students, letting them know how you enjoyed the visit. ◆

A GREEN CHRISTMAS
Activity Twenty-Two

Christmas should be about giving and sharing, not taking - like taking trees from the environment. Get students thinking about the amount of waste created, and waste of a natural resource, by using real Christmas trees and evergreen wreaths. Challenge them to think of alternatives!

Objectives To make students aware of the impact on the environment by consumers' demand for Christmas trees.

To make, and perhaps market, environmentally-friendly Christmas trees and wreaths.

Time Will vary according to project

Materials Use your imagination!

Procedure

1. Make students aware of the damage to the environment, and the vast amounts of energy required, to make available millions of Christmas trees and wreaths every year. A tree used as a Christmas tree could be at least 10 years old, and perhaps much older. The trees are then wasted. Check the Reference Material for more information on wood and trees.
2. For school - ask students if they could make decorations for an outdoor tree, decorations that may attract birds, that do not consume energy, are made from reused items, and will not harm the environment or wildlife.
3. What other kinds of materials can students come up with for making Christmas trees? The sky's the limit! Perhaps they can search their basements or garages for old, discarded or broken items which could be "recycled" into a Christmas tree! Or you could put one right on the wall, made out of coloured paper. All the classes could get involved in making decorations and a "low-energy" wreath for the classroom door.
4. Depending on the ideas generated, you may have a marketable commodity on your hands! Consider selling the plans or products to raise money for a Christmas charity. ◆

"GREEN" GIFTWRAP
Activity Twenty-Three

Many people don't consider the amount of waste produced by giftwrap - check a housing complex dumpster on Christmas day! Giftwrap finishes off a gift, and makes it special, by hiding what's inside - but can your students think of more intriguing and inventive ways to wrap gifts, that do not consume energy or produce waste?

Objectives

To make students aware of the energy consumed, waste generated, and damage to the environment created by giftwrap.

To challenge students to think of ways to cut down on waste and save energy by creating environmentally-friendly and energy-wise giftwrap.

Time

2 hours

Materials

Reference Material
Be creative!

Procedure

1. Read the Reference Material, and make students aware of our landfill crisis. Tell them that giftwrap contributes to this problem, especially at Christmas time.
2. Ask the students to think of ways that they could save on giftwrap. Ideas may include: wrapping in newsprint or the coloured comics section of the newspaper, making reusable giftbags or wrapped boxes. Students could also create their own giftwrap from reused paper, paint and brushes, and cut vegetables and dyes to stencil designs.
3. These innovative giftwraps could be a marketable product, which you could sell for a Christmas charity! This project could also be done at another time of year - for example, Mother's Day or Father's Day.
4. Encourage students to implement this idea at home. ♦

In the past, our lives depended on a close relationship with the environment and we felt connected to it. Now, many people, especially city dwellers, have lost this connection to nature. Try to re-establish this connection by planting trees to beautify the community, and to teach responsibility and respect for nature.

Objectives

To plant trees in the schoolyard or elsewhere in the community.

To learn that trees help absorb CO_2 in the atmosphere, and thus can help control global warming.

To help protect the building from excess heat, cold and wind by judicious placement and choice of trees.

Time

4 hours

Materials

Reference Material

Procedure

1. Contact Alberta Agriculture's Alberta Tree Nursery and Horticulture Centre for information on the type of trees suitable for your area and other planting advice. You may contact them at:

   Alberta Tree Nursery and Horticulture Centre
   R.R. #6, 17507 Fort Road
   Edmonton, Alberta T5B 4K3
   Telephone: 422-1789

2. Determine a suitable area for planting trees - either to beautify, or protect from wind. Consult the Energy Efficient Homes section of the Reference Material for landscaping hints to conserve energy. Check with administration and county offices to ensure that the land you have chosen is not crown land or owned privately. You may choose the schoolyard, a park or vacant land area, nursing home, etc.

3. Choose your location and type of tree carefully, and you can help reduce heating and cooling costs. For example, plant deciduous trees on the south side of the school near the windows. In the summer when they are covered in leaves, they will provide shade to help prevent overheating, but in winter months, the bare limbs will allow in heat and light from the sun. Coniferous trees planted to the north will shield the building from cold north winds and may help lower heating costs during the winter.

4. The Tree Nursery and Horticulture Centre may be able to help with acquisition of tree seedlings, or can direct you to an appropriate source. You may wish to ask them about the Arbour Day program, to see if you could participate. You may want to consider a field trip to the Centre for a school group tour.

5. Trans-Alta Utilities also has a planting program - check the Supplementary Resources section - Teaching Resources list and contact them.

6. Inform all participating students of the reasons for this activity - that the rainforests in South America and forests in Canada are being destroyed, that lack of trees promotes soil erosion, etc. Try to get them feeling involved in the program, so that the respect they will develop for these trees will extend to the rest of nature, and maybe they will share this feeling of concern with others. ◆

GUEST SPEAKERS
Activity Twenty-Five

Many people involved in energy and the environment are happy to speak to school groups about their field and their work. Your students will gain a valuable perspective, and career information, from guest speakers.

Objectives

To invite guest speakers in the energy or environment field to make a presentation to your school.

To increase students' awareness of career possibilities.

To increase students' and staff awareness of current issues in energy and the environment.

Time

Preparation: 60 minutes
Presentation: 30 minutes

Materials

Supplementary Resources section

Procedure

1. Check the Supplementary Resources section for groups to contact regarding guest speakers for your school.
2. Determine the best method for the presentation. For example, it could be included with a school assembly, or on a career day. You may also wish to invite parents or school jurisdiction staff to attend.
3. Clear the plan with the administration.
4. Contact the organization, asking them to make a presentation to your school. Be specific as to what areas you wish them to cover, what grades they will be speaking to, and the amount of time allotted. Ask if they will require any audio-visual equipment for their presentation.
5. Obtain any equipment required the day before the presentation. Check to make sure it is in working condition.
6. Before the presentation, have students develop questions to ask the speaker.
7. After the presentation, have the school thank the presenter, and perhaps give them a school pin or other memento of their visit.
8. Follow up with a thank-you letter to your presenter. They may appreciate a letter or drawings (on reused paper!) from your students. ♦

HEAT PATROL
Activity Twenty-Six

Get students involved in saving natural gas at school by finding and plugging up cracks and leaks.

Objectives

To have students find heat loss areas in the school.

Have students help plug up cracks and leaks using caulking or weatherstripping.

Time

Preparation - 3 hours
Caulking - 5 hours

Materials

Toothpicks
Down
Plasticine, cork or erasers
Glue
Caulking & caulking guns
Weatherstripping
Masking tape

Procedure

1. Decide which classes or students will carry out the two portions of the activity, searching for heat loss areas, and later caulking and weatherstripping these areas. If your school has elementary and secondary classes, you may wish to have lower grades make and use draft detectors, and junior high or senior high classes caulk and weatherstrip under the custodian's supervision.
2. Divide students into pairs. Obtain enough toothpicks and down feathers for each pair who will be searching for drafts. One container of glue (e.g., white glue, mucilage or rubber cement) should be adequate. Small pieces of plasticine, cork, or erasers will also be needed as a base for the draft detector.
3. To make the draft detector, stick the toothpick into the base. Dip the other end of the toothpick into the glue, and then carefully stick a small bit of down to the glued end. (See illustration on next page.)
4. Demonstrate to students that this tool will detect air movement, by blowing gently on it.
5. Ask students to consider some places around the school where cold air may leak in, or heated air leak out. Answers may include around doors and windows, where walls join, electrical outlets and light switches, etc.

6. Assign each pair a separate area of the school, telling them to check areas where heat loss may occur by setting the draft detector carefully on the sill, floor, or on the palm of their hand, watching for the feathers to move. This activity will work best on a windy day. Tell them to write down the exact location of the draft, and mark the area with a small piece of masking tape.

7. The activity could be concluded here with students making a presentation of their findings to the principal, or you could continue to step 8.

8. If funds are available, ask the custodian to assist in choosing caulking and weatherstripping appropriate to the areas to be sealed. Contact the Energy Efficiency Branch of Alberta Energy for a copy of the booklet "Caulking and Weatherstripping" from:

   2nd Floor, 10010 - 106 Street
   Edmonton, Alberta T5J 3L8
   427-5200 or toll free 0-Zenith 22339

9. You may wish to get students involved in fundraising to purchase required material.

10. Ask the custodian to spend approximately 30 minutes explaining to students the proper application of caulking and weatherstripping. Ask them to assist students when required.

11. Put students into pairs, and set them to work in assigned areas, sealing cracks with caulking or weatherstripping. ◆

JUNK MAIL RECYCLING
Activity Twenty-Seven

Every year, we get about a million tonnes of junk mail. Over our lifetime, we will spend 8 full months opening it. Not only does this junk mail fill up our landfills, but it consumes a lot of energy. If we could reduce junk mail, we could save thousands of trees every year. Plan to let the producers of the junk mail know that we do not appreciate this waste!

Objectives

To make students aware of the energy consumed and waste produced in the making of paper.

To involve students in sending back junk mail, reducing landfill waste.

Time

Preparation - 1 hour
Ongoing - 1/2 hour a week

Materials

Used envelopes
Tape
String
Collection box

Procedure

1. Make students aware of the large amounts of energy used in the pulp and paper industry. The Reference Material, Chapter 2, will give you some additional information.
2. Ask students and staff to bring in all the junk mail that they do not want from home, and store it in a collection box. Ask them also to bring in large used envelopes, and collect used ones from the school office, to return the junk mail.
3. Once weekly (or as often as required, depending on the amount of mail accumulated), gather together student volunteers to sort the junk mail according to its producer (e.g., supermarket chain, restaurant, coupon company).
4. Write a form letter to go to the originator, objecting to this waste.
5. Bundle together the junk mail from each location, including a copy of the form letter, and put it in an envelope or wrap in brown paper (old paper grocery bags could be used for wrapping).

6. Relabel the envelope using scrap paper and glue, and mail it back to the originator. Be careful that you send only what comes from that location.

7. To have your name removed from direct mail lists, send a letter and clip the mailing labels from unwanted direct mail items, and send to:

   Canadian Direct Marketing Association
   1 Concord Gate, Suite 607
   Don Mills, Ontario M3C 3N6
   (416) 391-2362

JUST DO IT!
Activity Twenty-Eight

How many times have you heard someone say, "Somebody should do something about this!"? Next time you hear that, ask them who the someone should be - as Michael Jackson says, "I'm starting with the man in the mirror".

Objectives To encourage students to take responsibility and develop empowerment by taking action on energy use and the environment.

Time 1/2 hour

Materials Supplementary Resources - "Special Interest Groups - for Students" list

Procedure

1. Photocopy the list of Special Interest Groups for Students from the Supplementary Resources section.
2. Tell students that there are many groups with which they can join forces to effectively make their views known, and influence industry and legislators.
3. Ask students to look through the list to choose a group in which they are interested. Encourage them to phone or write for information, and to become involved. Stress that if they are not satisfied with the first group, they should try again with another group.
4. Follow up in a month or two to see how many students have contacted groups, participated and stayed involved. ♦

LIGHT BRIGADE
Activity Twenty-Nine

Organize students to monitor lighting in your school - you could save hundreds of dollars in electricity charges per year!

Objectives To reduce the use of lights and save money on electricity.

To involve students in monitoring the use of lights.

Time Preparation - 2 hours

Materials Reference Material - Chapter 1

Procedure

1. Make up "Light Brigade Report Forms" indicating student duties, listing items to be checked and room for comments and check marks. Have students check lights in certain areas at specified times during the day, such as classrooms at recess and after school, the gymnasium and library at lunch hours, etc. This will vary according to your school. Instruct them to record all lights left on in unoccupied areas, and to turn them off.
2. Make students and staff aware that **ALL** incandescent and flourescent lights should be turned off if not in use for only **ONE** minute or more. Generally speaking, ALL fluorescent lights in use today do NOT cause a power surge when turned off and then on again - this was true many years ago, but these lights have been greatly improved.
3. Check the Reference Material, Chapter 1, Non-renewable Sources of Energy. The section on coal will indicate some of the potential savings on electricity.
4. Advertise the Light Brigade, and arrange a preliminary meeting of all interested students. Let them know their duties, and arrange reporting - students should share their findings daily with yourself or the designated staff person in charge.
5. This could be run as a one-week or one-month project, or could be ongoing throughout the year. The first week could be a training and awareness week, making students and staff aware of savings and developing good energy habits. Re-enacting the event later on during the school year can reinforce these positive habits. ◆

LETTER-WRITING PROJECT
Activity Thirty

Teach students to stand up for what they believe in, and to make their views known. Elected officials respond to public comment, and letters from future energy consumers (who are also future voters!) may convince them to improve environmental policies.

Objectives

To show students that they can voice their opinions.

To help students realize that their responsibility to protect the environment can be taken in many ways.

Time

60 minutes

Materials

Reused paper
Envelopes
Postage

Procedure

1. Ask students to discuss some of their energy and environmental concerns. Ask them who they think is responsible for making decisions on these issues - answers may include elected officials, or industry.

2. Obtain the addresses required, or have students obtain them. Addresses for Members of the Alberta Legislative Assembly can be obtained from:

   Legislative Assembly Office
   801 Legislature Annex
   Edmonton, Alberta
   T5K 1E4
   Telephone: 427-2477

   Addresses for Members of Parliament can be obtained from:

   Elections Canada
   toll-free 1-800-267-8683

   For municipal officials, contact your local City Hall, Town Hall, or County Council office.

3. On the blackboard, list some possible topics for letters. These may include energy and environmental issues such as pollution, deforestation, ozone depletion, energy efficiency, the greenhouse effect, recycling, acid rain, diversifying energy use, etc. Students should propose a topic, research it, and decide to whom the letter should be sent.

4. DO NOT USE A FORM LETTER! (These carry little weight with politicians.) You may need to remind your students of the format of a business letter, including the structure of introduction, body, and conclusion. Also, direct the students to use their home return address.

   The most effective letters are:

   1) brief,
   2) to the point,
   3) devoted to one environmental topic per letter,
   4) not overly emotional,
   5) clear about views and positions, and
   6) designed to require a reply.

5. Ask the students to write their letter on reused paper, and to write it neatly. Ask students to report back to class if and when they receive a reply. ◆

LIBRARY STORY-TIME
Activity Thirty-One

Consider what messages your students are learning during story hour, and be sure to include books on energy and the environment in your selection. Check your library's collection at the same time - could you add more books on these topics?

Objectives

To increase students' awareness of energy and environmental issues.

To encourage students to read books on energy and the environment.

Time

30 minutes

Materials

Library books

Procedure

1. Discuss this project with the teacher-librarian in your school, and enlist his/her help in looking for books in the library which relate to energy use and the environment. Check the Supplementary Resource section for new titles.
2. Ask the teacher-librarian to include books on energy and the environment in readings to young classes, and to perhaps consider a display of these books. ♦

LUNCH WASTE REDUCTION
Activity Thirty-Two

Help make your students aware of the waste from disposable packaging used in lunches. They are largely made from **non**-*renewable energy sources, which could be better used for transportation and heating homes. Challenge students to reduce landfill and energy waste by reducing their use of disposable lunch packaging materials.*

Objectives Reduce the amount of waste created by lunches.

Time 2 hours

Procedure

1. Make students aware of the waste created by disposable materials in lunches. You may wish to make announcements, collect waste from lunches, or count up the number of items wasted by type (e.g., lunch bags, plastic bags, plastic wrap, juice boxes or cans, etc.) and post totals on a poster.
2. Tell students about waste disposal in your area, making them aware of the time, money, energy, and land required for landfill sites, and the amount of time it takes these materials to break down in the environment. The Recycling Branch of Alberta Environment can help you with this - contact them at 427-5838 in Edmonton.
3. Ask students to think about the energy sources used to make these materials - energy that is used only once and then wasted, e.g. trees for paper bags, and natural gas and oil for plastic.
4. Ask students how this waste can be reduced. Some ideas may include making reusable lunch bags, making or using cloth napkins, using plastic containers, etc. See activities 38 and 39 for more information.
5. If students wish to make cloth napkins, ask them to bring fabric scraps from home, and have a workshop for hemming napkins.
6. Encourage students to use plastic containers. If interest warrants, you might order plastic containers in bulk to make them available for purchase by students at a reduced price.
7. Don't forget the staff! Encourage them to "green up their act" by using reusable containers instead of disposable materials. Also consider the staffroom - do you use styrofoam cups? Plastic stir sticks? Bleached coffee filters? Paper towels and napkins? Individual sugar packets? Make your staff room more environmentally friendly. ♦

MOVIE NIGHT
Activity Thirty-Three

Sometimes, the reason that people are not more involved in protecting energy sources and the environment, is that they lack knowledge. Help educate the community to the facts, so that they can make informed decisions.

Objectives

To increase students', staff, and parents' awareness of energy and environmental issues.

To raise money for energy-related or other projects.

Time

Preparation: 3 hours
Movie Night: 2 hours

Materials

Chairs
Movies on energy and the environment
Paper and felt pens

Procedure

1. Determine whom you would like to include in this event, and where and when it should be held.
2. If you wish to charge for people attending the movie night, ensure that this does not violate copyright.
3. If you wish to sell snacks and drinks, make the appropriate arrangements, and determine pricing. Avoid using throwaway items - ask audience members to bring their own cups and napkins from home. Selling refreshments could raise money to cover or offset the cost of the film, and to put towards an activity such as protecting the rainforest through the "Guardian of the Rainforest" program (see Supplementary Resources section - Teaching Resources), or purchasing resources for the school library.
4. If you will be charging for admission or snacks, determine where the funds raised will go.
5. Check the Supplementary Resources section - Videos and Films - for movies on energy and the environment which would be appropriate for showing to your group. Contact the organization supplying the film or video well in advance to check on availability, costs involved, copyright regulations, and shipping arrangements.

6. Discuss your project with the custodial staff to determine any special considerations, and to book the room and ensure chairs will be set up.

7. Publicize your event by having the principal make announcements, have it included in any information going home to parents, make posters to hang at the school and perhaps around the community.

8. Ask the custodian and other volunteers to help set up the room on the night of the event, and to assist in clean-up afterwards. ♦

NEWSLETTER
Activity Thirty-Four

An interested student group or environment club may wish to produce a newsletter with energy and environmental information and tips for students or families. This would also be a good special project for an English or Language Arts class.

Objectives To increase awareness of energy and the environment.

To encourage empowerment and responsibility.

Time 2 hours per month

Materials Paper
Supplementary Resources section
Reference Material

Procedure

1. Give students some guidelines to begin with, for example, that a monthly publication is a fair time commitment for members. Stress that they must write the articles themselves, have them approved by the teacher assisting them, help with making a stencil or copymaster, running off sufficient copies, and distributing the newsletters.
2. Determine what number would be feasible to produce, and inform students. Consider the school or community population, cost of paper, postage, and time involved. You will probably want to limit each issue to one page, single or double-sided.
3. Obtain permission to use school equipment and paper to produce the newsletter, and perhaps to include it with a mailing to parents to reduce costs.
4. Give students a deadline for each issue. Assign student duties, such as pasting together a copy master, running photocopy machine, etc.
5. To save paper, it may make more sense to give only one copy to each classroom, to be posted or read by the teacher.
6. Give students a copy of the Reference Material and Supplementary Resources sections for information. ♦

"NOT IN MY BACKYARD"
Activity Thirty-Five

Everyone feels the same way about landfill dumps - yes, they are needed - but not in **my** *backyard! Give students an appreciation for the complexities of this real-life problem by staging a "town meeting" with students playing pre-determined roles to discuss choosing a new location for an imaginary new landfill site.*

Objectives

To make students aware of the many complex issues involved in energy and environmental decisions.

To have students assume and play roles.

Time

Preparation - 3 hours
Role Play - 1 hour

Materials

Index cards
Chairs

Procedure

1. Choose an appropriate date for the role play, reserve a room and arrange for chairs and tables.
2. Decide how you will choose students to play the roles - you may want to have a representative from each class, members of one class only, or perhaps a speech or debate team.
3. Write up a scenario of a landfill site to be located near your community (maybe choose a real location to make it easier for the students to relate to). Decide on roles - some examples include residents opposed to the site, environmentalists concerned about the negative impact this will have on local water supplies, a local trucking company who stands to win a lucrative contract to truck the waste to the landfill, local politicians, some opposed and some in favour of the project, etc.
4. Write up an index card for each role with a brief description of the role and their character's position on the issue. Distribute these to the role players about 1 - 2 weeks in advance to allow for preparation.
5. On the day of the event, have chairs arranged for the players at long tables at one end of the room, with the rest of the room arranged audience-style.
6. Have the players debate the issue, and allow a discussion to follow on the pros and cons brought up by each perspective. You may wish to conclude with a vote on whether or not the audience thinks the landfill site should go ahead. ♦

OUTDOOR ART
Activity Thirty-Six

Take your art classes outside, and have them personalize the tarmac with a message about energy conservation or the environment! The chalk drawings will last only a few days, but students will long remember their "art al fresco" experience.

Objectives

To have students create a composition using non-traditional media.

To allow students the chance to make a personal expression of their views on energy conservation.

Time

Preparation - 1 hour
Event - 1 hour

Materials

Coloured chalk (non-toxic)
Camera and film

Procedure

1. Compile a list of topics.
2. Divide the total tarmac area by the number of art classes or students participating, and assign equal areas to each group.
3. Speak to all art teachers, ask them to spend 1 or 2 class periods during the week on this project. They will need to introduce the project to the class, choose a topic, and then spend one class period decorating their portion of the tarmac.
4. Distribute chalk to every class at the beginning of the week, and have a volunteer photograph each completed project. Try to have them all completed within two days of each other if possible, so that all drawings will be fresh at the same time.
5. The media may find this a very newsworthy and photogenic project - give them a call! ♦

Your students' enthusiasm for saving energy and reducing waste can help convince others - get them making reusable grocery bags to take home, or to sell for fund-raising.

Objectives

To have students make reusable grocery bags to use instead of disposable bags.

To sell bags for fundraising.

Time

2 hours to make bags

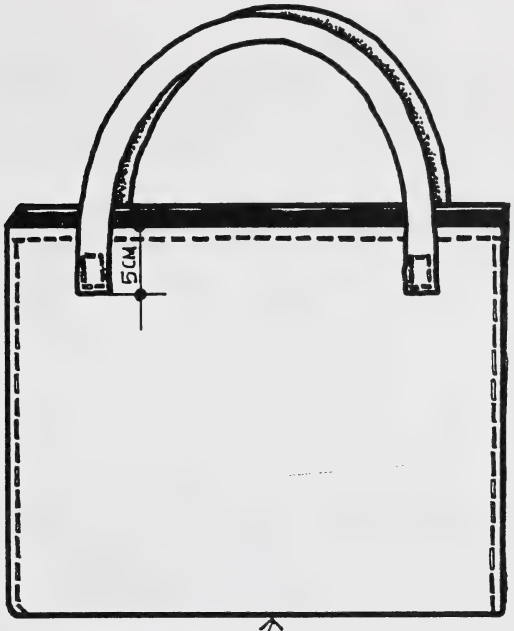
Materials

Fabric (suitable types include canvas, nylon, denim, etc.), enough to cut out four pieces 42 cm x 50 cm, and one strap 20 cm x 85 cm
Nylon strapping (optional)

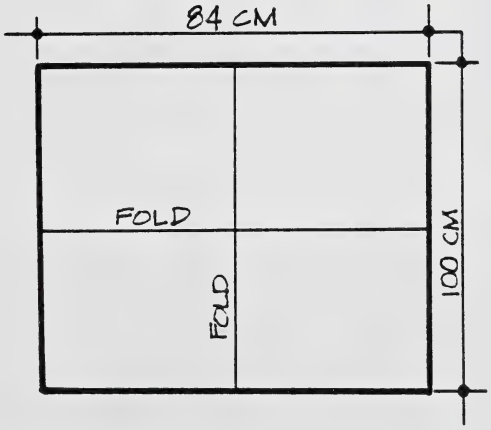
Procedure

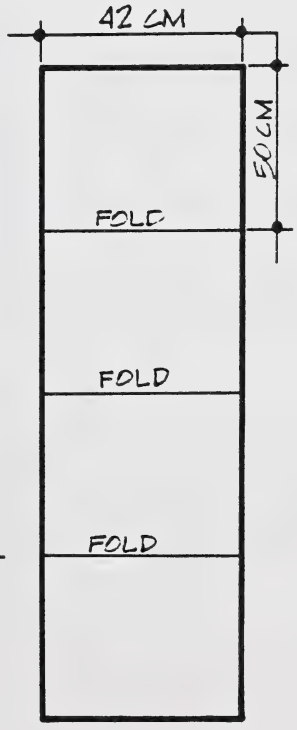
1. Have students bring in fabric remnants from home, or you may be able to order large quantities at a discount through the school.
2. Use the pattern on the next page, or draft your own. Make several copies on newsprint so that several students can work at the same time.
3. After bag has been cut out, students may add any decoration or personalization that they wish.
4. Each side of the bag will be double-thickness; if necessary, sew the pieces together first. Sew side seams and bottom if necessary. Leave one end open. Double stitch all seams for extra strength. Hem the open end.
5. Fold strap pieces in half lengthwise twice (see diagram), then stitch.
6. Attach straps securely to each side of the bag, overlapping 5 cm. ♦

REUSABLE GROCERY BAG
SUGGESTED PATTERN



STRAPS: 20 CM × 173 CM





REUSABLE JUICE JARS
Activity Thirty-Eight

Many students bring juice to school in "tetra-paks", individual serving-sized juice boxes made of cardboard, foil, and plastic with a drinking straw attached. Make students aware of the over-packaging in these products, and perhaps they'll be convinced to bring juice in a more energy-wise and less wasteful container.

Objectives To make students aware of all of the energy wasted by over-packaging, specifically in juice boxes.

To get students to use reusable beverage containers.

Time 1 1/2 hours

Materials Jars or plastic containers, with tight-fitting lid

Procedure

1. Discuss with students the materials used to make juice boxes - their list should include juice, (including water, sugar, colouring, etc.), paper/cardboard, foil (lining), and plastic (coating and straw), and then ask them to name the energy sources used to make each of them, e.g.:

   paper/cardboard - trees
   foil - metal, aluminum
   plastic - natural gas or oil

2. Ask students to consider all of the other energy involved, such as in manufacturing and transportation.

3. Trace the life cycle of a juice box after they drink it - it is thrown in the garbage, the janitor collects the garbage, the garbage truck takes it to a landfill, and all of these juice boxes contribute to the overcrowded landfills. Consider the life cycle in terms of biodegradability - the plastic may never break down, nor the aluminum - so the carton will, essentially, live forever! All for one tiny drink of juice!

4. Ask students to think of reusable containers they could use for juice and what factors they must consider, such as size, durability, a container easily washed and carried. The containers can be decorated with glass paint, such as Talens' Hobby Color for Glass.

5. Begin monitoring the number of juice boxes thrown away, to see if the number decreases. Student volunteers in the lunch room could count them. ♦

Challenge your students to think about the energy used and waste created by the simple brown paper lunch bag - the trees that are destroyed, the damage to soil from deforestation, and the intensive energy use in the pulp and paper industry. Can you make your school a "brown bag free" zone?

Objectives

To increase students' awareness of the waste created by using disposable paper bags for lunches.

To have students make reusable lunchbags.

To decrease waste from lunches.

Time

2 hours

Materials

Lunchbag pattern (see next page)
Fabric piece(s) approx. 30 cm x 70 cm (ask students to bring fabric scraps or old clothing items - maybe blue jeans! - from home)
Carrying strap material (e.g., ribbons, shoelaces, cord)
Trim (e.g., rick-rack, braid, lace, fabric paint, etc.) if desired
Needles and thread

Procedure

1. Make a sample lunchbag using the attached pattern. (You'll have to draw your own as ours is not to scale.)
2. Ask students to bring in fabric scraps from home, and any trimming they would like, for making their lunch bags.
3. Encourage students to share patterns rather than making one per person.
4. Have students cut out pattern pieces, and add any decoration they wish. Then direct students to sew together the sides, leaving an opening at the top. This will be turned over to make a casing for a drawstring.

NOTE: This activity would fit in very well in an Art or Home Economics class, or could be done at lunch hours or after school.

5. The School Milk Program of the Alberta Dairy Products Promotion Board is selling attractive and practical reusable lunchbags for students at an affordable price. If you wish to purchase them for your school, or for a fundraising project, contact:

   Jan Waldon, School Milk Program
   Alberta Dairy Products Promotion Board
   14904 - 121A Avenue
   Edmonton, Alberta T5V 1A3
   453-5942

FOLD

7CM

7CM

STITCH FOR CASING

REUSABLE LUNCHBAG PATTERN

Directions:

1. Pin pattern to a double thickness of fabric, placing one edge along fold of fabric if possible (reduces sewing required).
2. Decorate the right side of the fabric as desired with fabric paint or sewing on buttons, other fabric scraps, lace, trim, etc.
3. To form casing, fold over 7 cm at both ends of fabric. Stitch.
4. Sew up side seams, and bottom seam if necessary.
5. Thread cord or ribbon through casing, sewing or tying together loose ends.

Please note: This pattern is <u>not</u> to scale - use as a guideline, following measurements, to make your own

PLACE ON FOLD

70 CM

30 CM

SAVE THE RAINFOREST
Activity Forty

The Amazon rainforest is being cut down at an alarming rate, to clear land for raising fast-food beef and cash crops. This deforestation contributes to the greenhouse effect by depleting one of the most important absorbers of excess CO_2, and from the accumulation of smoke in the atmosphere from burning the felled trees.

Objectives

To get the whole school involved in saving the delicate and important ecosystem of the rainforest.

To encourage empowerment in students.

Time

3 hours

Materials

Save the Rainforest kit - see the Supplementary Resource section for ordering information.

Procedure

1. Check the Supplementary Resources section, under "Teaching Resources" for information on ordering this kit.
2. Once you have obtained the kit, determine a fund-raising method for your class/school. Some of these could include ideas found in other activities in this guide, or bake sales, yard sales, recycling newspapers or bottles, car washes, hot dog sales, etc.
3. Let the other staff know about this project and how important it is. Encourage them to get involved.
4. Upon completion of your project, publicize your success. Make sure everyone in the school, parents, and school jurisdiction staff hear about it, and the local media (newspaper, radio, television) may be interested enough to cover it.
5. If students are motivated to do more, ask them to consider letting fast-food companies know how they feel, and refusing to buy their products; or writing the World Bank asking them to review their development projects in developing nations.
6. Have students investigate deforestation in Canada. For example, many old-growth forests in B.C. are being threatened, and new pulp mills in Alberta may increase tree harvest. ♦

Children learn what they live - help them to live recycling by getting your school involved. This may persuade them to make an effort to conserve energy by recycling.

Objectives To get your school, staff, and students involved in recycling.

Time Preparation: 4 hours

Materials If you are going to set up your own program, obtain an appropriate collection bin.

Procedure

1. Contact the Recycling Branch of Alberta Environment for information on local recycling organizations. (See the Supplementary Resources Brochures list for address.)
2. Decide if you wish to get involved in an existing program, e.g., Paper Chase Recycling, or if you wish to start up your own program.
3. You may wish to contact SEEDS (see Supplementary Resources), as they are encouraging environmental programs in schools.
4. To get involved with an existing program, contact that organization.
5. Opportunities for recycling may include having regular bottle, paper or metal can collection and taking the materials to a recycling depot. Consider that you will have to have an appropriate site at the school for collection, materials need to be sorted prior to delivery to the depot, and transportation must be arranged. Clear the collection site with the school administration and custodial staff, get information on proper sorting from the Recycling Branch or a recycling depot, and arrange for regular delivery to the depot.
6. Publicize your recycling effort throughout the school, and in information going to parents.

7. Don't forget to get the staff involved! Use reusable cups instead of styrofoam cups for visitors, spoons instead of plastic stir sticks, sugar in a dispenser instead of individual packets, asking teachers to bring in their newspapers from home, etc.

8. Make sure your office is also reducing waste, by using mechanical pencils and refillable pens instead of disposable ones, recycled paper in the photocopier, water-based instead of solvent-based markers (check the art room, too!), and refillable tape dispensers instead of disposable plastic ones.

9. Recycle clothing, toys, and household articles. Once per year, clean out the lost-and-found box and donate abandoned clothing or other articles to a local women's shelter, the Salvation Army, Goodwill, or church, or have a school yard sale to raise funds for the school or a local organization. Students and staff could also contribute unused articles from home. ◆

SPRING CLEAN-UP
Activity Forty-Two

Teach students to have pride in and care for their environment by organizing a schoolyard clean-up, at least once a year. They may then extend this attitude to their homes, and the outdoors.

Objectives To teach students to take responsibility for their environment.

To keep the schoolyard clean and free of litter.

Time 1 hour

Procedure

1. Determine if you want to have only the schoolyard cleaned, or if you wish to extend the clean-up to local churchyards, nursing homes, daycare centres, etc. If necessary, obtain clearance for the activity from the administration.
2. Ask students and staff to bring in old plastic or paper bags from home for collecting garbage.
3. Divide the area to be cleaned into sections and assign one to each class.
4. Set a time limit to the activity, clearly define boundaries, and provide adequate supervision.
5. Classes could be challenged, with a prize going to the class which collects the most garbage.
6. Sort the garbage collected into compostable and recyclable items. ◆

STAFF MEETING TIPS
Activity Forty-Three

In our visits to schools, we often notice that the students remember to save energy, while teachers sometimes leave the lights on, use disposable lunch materials, and let cars idle! Once a month, provide the staff with information or tips on energy conservation or environmental protection at a regular staff meeting.

Objectives

To make staff members more aware of the importance of energy efficiency and environmental protection.

To encourage staff members to practice energy conservation and environmental protection.

Time

Preparation - 1 hour
Monthly - 5 minutes

Materials

Reference Material

Procedure

1. Review the Reference Material for information and tips of interest to your staff.
2. Review the Supplementary Resources section for other publications, such as brochures, which you may wish to display in the staffroom.
3. Consider inviting a guest speaker to one of your staff meetings, or for a Professional Development day, to provide more information.
4. Speak to the principal or staff meeting chairperson for permission to include an energy or environment tip at every meeting.
5. Keep the staff informed of any school events or activities to gain their support and understanding. ♦

TIP TREE
Activity Forty-Four

Each student can participate and share their ideas about how they can save energy and the environment in this fun school display. Encourage teachers to get involved, too!

Objectives

To make a display of energy conservation/environmental tips in a prominent location in the school.

To make all students more aware of how they can take responsibility for protecting the earth's resources.

Time

Preparation - 1 hour
A few minutes a day for one week

Materials

Brown paint or paper (approx. 2 m^2)
Green paper (10 cm x 15 cm for every student)
Masking tape

Procedure

1. Obtain permission to display a mural on a prominent wall, such as in the lobby or the library.
2. Paint a tree trunk and limbs on the wall, or make it out of coloured paper. If you paint on the tree, you may use it year after year, replacing the leaves. Depending on the size of the wall, the tree should measure approximately 2 m tall, and 2 m at its widest point. Attach a cardboard box to the wall, or set it on a nearby table, containing masking tape and scissors for the students to attach their leaves to the tree.
3. Distribute a few leaf patterns and enough sheets of green paper for every student to each class, and ask the teacher to spend a few minutes of class time to have the students trace and cut out their leaves.
4. Direct students to write an energy conservation or environmental tip on the leaf, and affix to the wall with masking tape. ♦

LEAF PATTERN

TOURISM PROJECT
Activity Forty-Five

Tourism can bring economic benefits to an area, but too often the environmental impact is not considered. Energy is required to build and maintain these developments, and access roads may cut through natural areas and threaten the ecosystem.

Objectives

To make students aware of the impact on the environment of tourism developments.

To challenge students to design a tourism development for their area which is "environmentally-friendly".

Time

2 weeks

Procedure

1. Contact your local Tourist Industry Association for brochures and information on tourist developments in your area. You may choose one development for study, or students may select their own. Find out when it was built, whether highways were built for access, if an environmental impact assessment was done, etc.
2. For information on tourism development, contact Cole Pederson, Alberta Tourism, Co-ordinator of Public Awareness, 3rd floor, CityCentre, 10155 - 102 Street, Edmonton, Alberta T5J 4L6, telephone 427-7612.
3. Design the "ideal tourism development" for your area. You may wish to make it a co-operative effort among several classrooms, with one group performing the environmental impact assessment, another sketching the project, another developing a marketing plan complete with brochures and posters, etc.
4. After you have completed your plan, you may wish to have a group of students present it to the local Chamber of Commerce or Tourist Industry Association, or send it to Alberta Tourism, at the above address. ♦

WALL MURALS
Activity Forty-Six

Provide an outlet for artists and graffiti scribblers - let students express their own personal view on energy and the environment in colourful murals on school walls.

Objectives

To allow students to decorate school walls with murals.

To display energy and environmental messages throughout the school.

Time

4 hours

Materials

Acrylic paints
Brushes

Procedure

1. Determine how students will be chosen to paint murals - will they apply, as individuals, groups or classes? Will they be appointed by classroom or art teachers?
2. Select walls which you think would be appropriate for murals, and obtain permission to have them painted.
3. Have students submit a proposed design for approval, to screen subject matter.
4. Supply materials to students, and give them a date by which work must be completed. ♦

WATER CONSERVATION
Activity Forty-Seven

Before we ever draw it from a tap, our water has gone through a long, energy-consuming journey including pumping, cleaning and purifying, and heating. Ask students to think of ways to use less water, and less energy.

Objectives

To make students aware of the energy required to clean and heat water for domestic use.

To have students assist in the effort to conserve water, and the utility costs associated with its use.

Time

2 hours

Materials

See Procedure - materials required will vary by activity

Procedure

1. Make students aware of the energy required to clean and heat water, and any other water facts, from the Reference Material, Chapter 2.
2. Check water use around the school - look for dripping or leaking taps, uninsulated hot water heater or pipes, running or leaking toilets.
3. Have some students make posters encouraging water conservation to be placed in washrooms, by water fountains, etc.
4. Check for dripping faucets or leaking water pipes around the school. Have students prepare a report to be presented to the principal and custodian outlining methods which can reduce water waste. If appropriate, students may assist in changing washers, installing flow restrictors, etc.
5. If the hot water tank is uninsulated, students may suggest that an insulating blanket be made or purchased to reduce heat loss. The thermostat on the hot water heater should also be checked. A setting of "medium" or 50 ^{o}C should be adequate for most hot water needs.
6. If toilets are equipped with a standard tank, toilet dams can be installed. Students can make toilet dams by filling a plastic container with water and stones, sealing it, and setting it in the toilet tank. The volume of water displaced in the tank must not exceed one-third of the tank's total possible volume of water.
7. For more water conservation ideas, contact the Water Conservation Section of Alberta Environment, at 427-2375 in Edmonton. ♦

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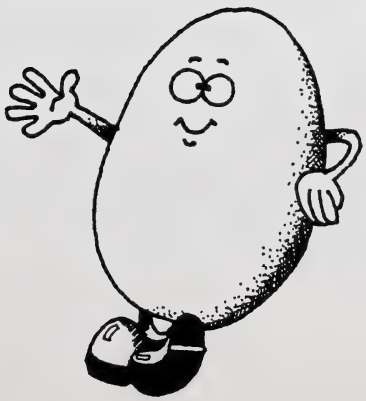


2. REFERENCE MATERIAL

Foreword

Save Energy - Why?

> *"Utilities build lots of plants and can't pay for them. People use less power, but we need more - and maybe they'll use more if we charge more for it ... Does any of this make sense to you?"*
>
> *- Amory B. Lovins*

North Americans have become accustomed to a way of life which allows us to use more and more energy, because of frequent technological discoveries. We use more energy per capita than any other country in the world - twice as much as the highly-industrialized and comfortably-living West Germans, and four times as much as New Zealanders!

Maintaining our lifestyle requires energy, which is almost exclusively supplied by the non-renewable fossil fuels of coal, oil and natural gas. In our constantly growing demand for convenience, we have become dependent on these finite sources. Albertans are accustomed to cheap energy from the fossil fuels because they are found plentifully in our province - but perhaps there are other energy sources we could use.

Homes are not usually heated with only one energy source. Although most Alberta homes are heated by natural gas furnaces, we also use insulation and weatherstripping to keep the heated air in the house, we get heat from the sun as it shines through our windows and warms the atmosphere, we may use a fireplace from time to time, and we'll even put on a sweater if it gets a little chilly.

If we apply this reasoning to our energy use, we could consider other energy sources to complement our use of the fossil fuels. Perhaps conservation measures and renewable energy sources which are not depleted with use or can be regenerated quickly, can fit into the "energy pie" which we draw from. If we considered our end uses, that is, what the energy used will ultimately provide us, we may find that home heating can be more appropriately supplied through passive solar energy, electricity through wind generation, and automobile fuel from biomass.

Because Alberta's economy is resource-based, our economic health is dependent in part upon energy production. In the recent past, we have seen the effect on our economy of decreased demand, lower prices, and changing political environments. But renewable reserves would not be affected in the same way - the wind blows whether or not we need more energy, and political manoeuverings cannot stop the sun from shining. A more varied energy mix could increase economic stability and help ensure a sustainable energy supply. But we must lay the foundation today. Perhaps if we slow down the rate at which we consume non-renewable energies and use energy more efficiently, we will buy some time in which to develop renewable or alternate technologies. If we do not manage our reserves of fossil fuels wisely, we could face another energy crisis, perhaps greater than the one which occurred in the mid-1970s.

We hope that through using this classroom resource, you and your students will find your own reasons to make energy conservation, efficiency, and protection of the environment a personal commitment. Many people feel that they cannot make a difference on their own. But truly, the responsibility for change lies with us, not someone else. It's not somebody else's problem, we share it. We can't wait for someone else to take care of it, we must work together towards a more secure energy future. Be one of those who is committed to facing the challenge.

CHAPTER 1

NON-RENEWABLE SOURCES OF ENERGY

Non-renewable sources of energy, by our definition, means that the resource is finite and irreplaceable. These include coal, oil and natural gas, sometimes called **fossil fuels**, and nuclear energy.

INTRODUCTION - It takes millions of years to make fossil fuels - the coal, oil and natural gas we use today are made from compressed layers of ancient vegetation, buried by layers of soil and rock. Over the millennia the pressure created these energy sources. In Alberta, we are dependent on coal, oil, and natural gas. Other areas of North America rely on these sources as well as nuclear energy. Some energy sources are called **primary** energy sources, meaning they are used in their natural state, without processing or being changed into other forms of energy. **Secondary** energy sources, however, are energy sources made from another form - electricity for example. Not only do we place a heavy demand on the non-renewables for secondary energy sources, but we also use them as feedstocks, or raw materials, for consumer products such as making plastics from oil and natural gas.

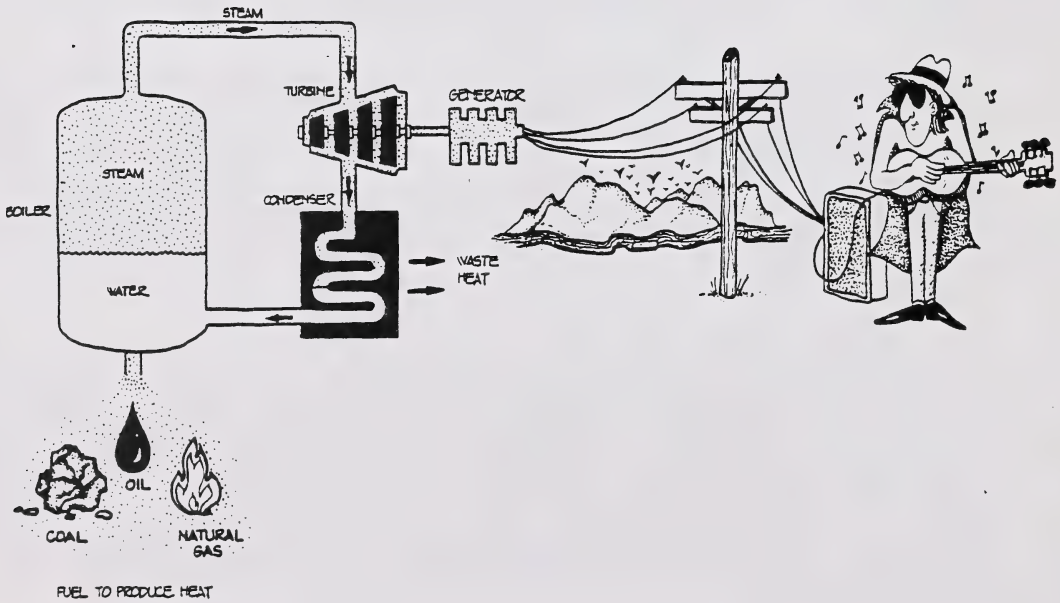
Canada is considered to be "resource rich", and indeed we are blessed with large supplies of natural resources. But to put this in perspective, we produce only 4% of the world's primary energy supply. Currently, our largest energy trading partner is the United States, who receive 81% of our energy exports. We are, in fact, their biggest foreign supplier of petroleum and electricity, and are therefore not immune to the sensitive and sometimes volatile world market.

There is no doubt that these energy sources are versatile, and that they have contributed to our quality of life. However, we are depleting the existing reserves and must live with the consequences of a dwindling supply. The term **reserves** means proven reserves, not yet used, which are recoverable using current technology. Reserves can fluctuate for several reasons, for example, if new ones are discovered, or if recovery techniques are improved or new ones developed, etc. The following section describes each energy source and its present and forecasted availability and use. We hope that it will give you and your students the information needed to make responsible decisions as energy consumers.

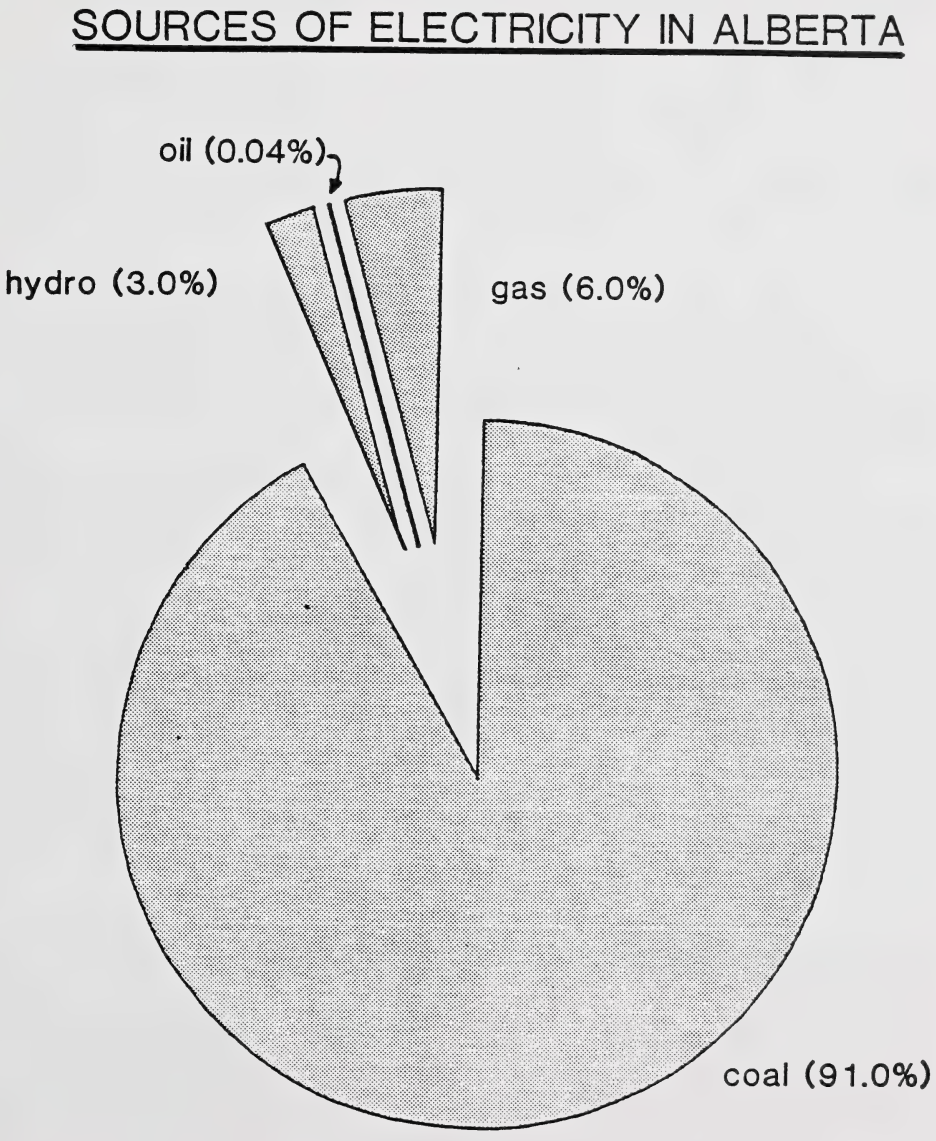
I. COAL

- Coal was instrumental in our economic development, with the first mine in production in 1872 near Lethbridge. In 1900, before the discovery of great oil and gas reserves in Alberta, coal supplied about 80% of the country's primary energy needs. It was the fuel most commonly used for heating homes and fuelling steam locomotives in the first half of this century. It was replaced by cheap and clean-burning oil and natural gas, both available locally in abundance. Approximately 46% of the total land area of Alberta is underlain by coal deposits, equal to 300 000 square km. Coal is Canada's third largest mineral export after oil and natural gas. Within Canada, 97% of Canadian coal is used as fuel for generating electricity in Alberta, Saskatchewan, Ontario and Nova Scotia. See Figure 1. Coal now produces well over half the world's power, and about 9% of Canada's energy needs.

There are two important types of coal mined in Alberta - thermal coal and metallurgical coal. Thermal coal is most suitable for heating, and is widely used in some areas of the country to provide steam for electricity-generating steam turbines. Today in Alberta, over 90% of our electricity is produced from coal with only 3% being produced by hydroelectric power, and the tiny remainder from natural gas. See Figure 2. The first coal-fired electricity-generating plant in Alberta was constructed at Wabamun in 1957.



THE PRODUCTION OF ELECTRICITY
FIGURE 1



SOURCES OF ELECTRICITY IN ALBERTA
FIGURE 2

Alberta's metallurgical coal is widely used in the production of steel. Our major markets for coal are Japan, Ontario and Brazil, with smaller amounts also going to British Columbia, Belgium, Germany, Iran, Korea, Sweden, Mexico, and the United States.

Canada has between one and two percent of the world's coal reserves, with Alberta's reserves accounting for 70% of the total Canadian reserves at 22 billion tonnes. If current consumption rates continue unchanged, and even if no further sources are discovered, coal should be able to supply our energy needs for at least 900 years.

Besides its many benefits, there is controversy surrounding its use and production. It is a dirty fuel and dangerous to mine; it creates dust and can cause black lung disease in miners. Explosive methane gas is also released by coal mining operations, the majority of which are large mining complexes, 96% being surface mines. These surface mines can damage and disfigure the landscape, although regulations in Alberta stipulate that the land from abandoned mine sites must be reclaimed to a productive state equal to or greater than its original state, usually as agricultural, forest, or wildlife habitats.

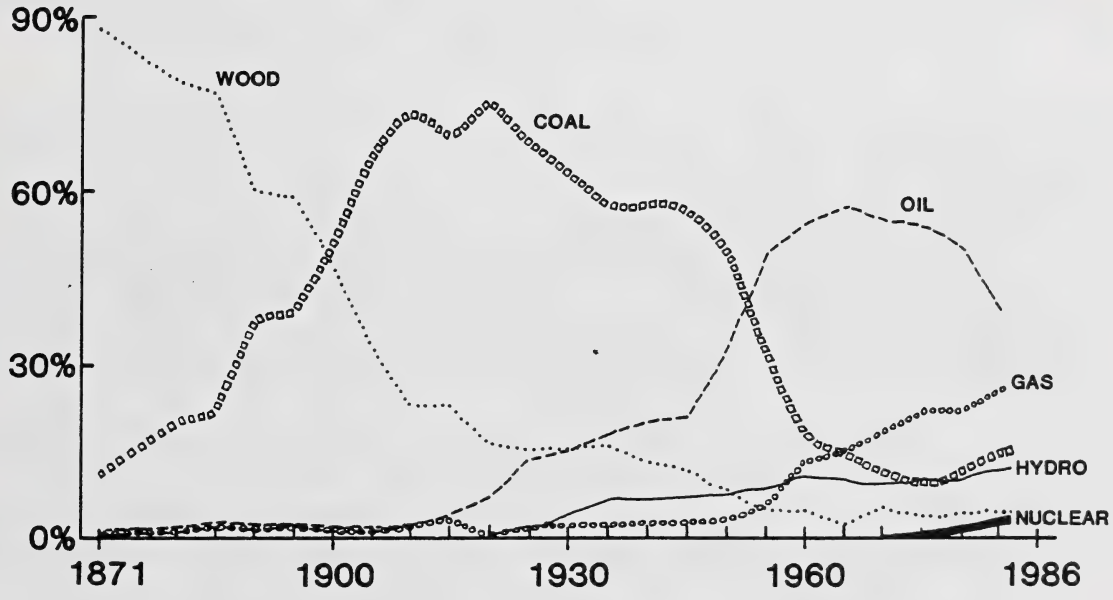
Coal is very expensive to transport; therefore, while we may have abundant reserves within Canada, Ontario finds it less expensive to import coal from the United States. This eastern American coal is not as clean as Alberta's coal, however, and emits more sulphur dioxide which contributes to acid deposition. In Ontario and elsewhere, to combat the environmental drawbacks, scrubbers are used in the final combustion process to remove pollutants from the air being exhausted. This process, however, increases costs significantly.

In practical terms, the conservation of coal can be accomplished by reducing electrical consumption. For example, if every classroom in an average Alberta school turned off the lights for 1 ½ hours every teaching day (or during lunch hour and recess/class breaks), this would provide savings to the school of approximately $374.00 annually. This would be equivalent to saving 3.7 tonnes of coal - or enough to fill a dump truck to overflowing.

In normal coal-burning power plants, about two-thirds of the energy goes straight up the smokestack. Systems are now being developed to make coal a cleaner fuel, and the newest generation of coal-fired electrical installations are much more efficient and cleaner-burning. Also, researchers are looking for possible future uses of coal. For example, it can react with hydrogen to produce synthetic gas or liquid hydrocarbons which can replace natural gas as a feedstock for petrochemical production. If it is used, however, as a replacement for oil and natural gas, what will happen to the price and availability of coal if it is consumed at the same rate as oil and natural gas? We know that the reserves of coal are extensive, however, they will not last nearly so long if there are further demands placed on those reserves.

II. PETROLEUM (OIL AND NATURAL GAS) - Oil and natural gas are versatile energy sources, providing most of our **primary energy needs.** "Primary" energy refers to energy sources in the raw state, before they are turned into other energy forms such as thermal electricity, or into industrial products. See Figure 3. Alberta has known reserves of oil of approximately 3.6 billion barrels of conventional crude and about 25 billion barrels of oil from the oil sands. Without continued exploration and discovery, Alberta's reserves of conventional crude oil would last only 10 years at current rates of consumption.

Our light crude production peaked in 1973 but has been declining ever since. This decline in production is due to several factors. In Alberta, development of petroleum reserves is controlled, so that there are always some reserves left in the ground, for future use or development when recovery becomes more cost-efficient.



PRIMARY ENERGY BY SOURCE , CANADA
1870 – 1986

PRIMARY ENERGY BY SOURCE, CANADA
1870 - 1986
FIGURE 3

We export oil mainly to other Canadian provinces, and some to the United States. Alberta produces a full 82% of Canadian crude oil, with Alberta and Saskatchewan together accounting for a whopping 95% of total Canadian production. Worldwide, however, Canadian production accounts for only 2.7% of the world's supply. We are not energy self-sufficient, and must supplement our energy needs with imports. Alberta oil cannot economically be transported to Atlantic Canada, for example, and oil is imported into that region from other countries. Our production of natural gas accounts for 89% of Canada's production, and 4.4% of the world market.

At the time of the first major oil discovery in North America, in Ontario, petroleum was used to produce chewing gum, paint, and kerosene, and no one recognized the importance of the find. The Canadian industry moved west at the turn of the century when natural gas was found near Calgary. By 1925 it was moving in pipelines to heat southern Alberta homes, to power industry and to light the streets of Calgary.

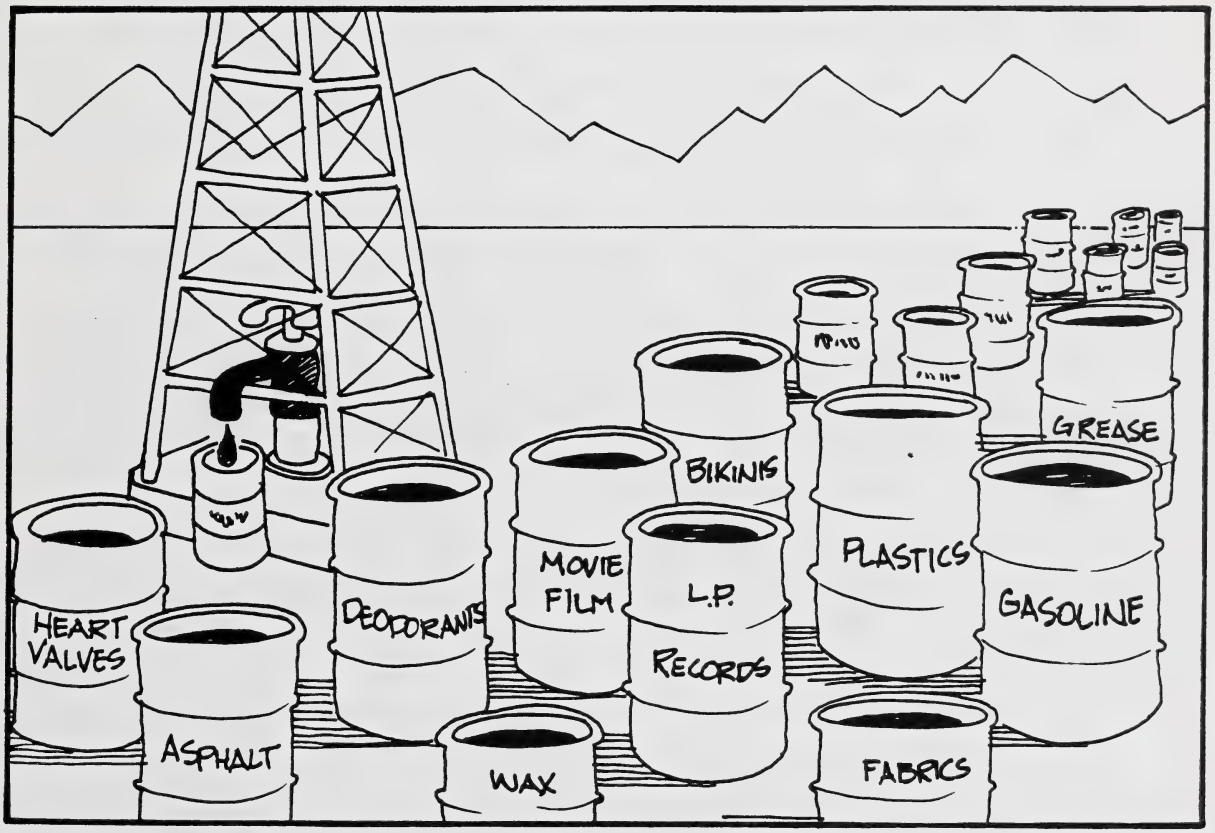
In 1914, Turner Valley in Alberta became the site of the first large-scale drilling operation for crude oil in the Canadian west. The industry was centred in this area for many years; however, by the early 1940s, production had declined to a point where 90% of Canada's needs were being met by imported oil. In 1947, Leduc No. 1 was drilled - a tremendously important event in the oil industry, as it exposed the largest petroleum deposit yet discovered in Canada.

Canada continues to explore for new deposits of oil, in the land along the coastal shelves, in the Beaufort Sea and off the coast of Newfoundland and Labrador. When one considers the derrick, the machinery, and the crew needed to drill an oil well on land, drilling the sea bed for oil, such as in the Hibernia oil field, 300 km from Newfoundland, under 90 m of water, seems impossible! In the Beaufort Sea, work has been done differently. In 1971, ESSO built the first artificial island in the Beaufort Sea in shallow Arctic waters. But very special methods are needed to drill offshore, making it more difficult and expensive to retrieve this petroleum. Since 1973, natural gas has become more profitable to retrieve and therefore became more accessible and attractive for use. In prosperous times, increased exploration uncovers new reserves, but in recent years an unfavourable economic climate has discouraged exploration, and therefore further reserves are not discovered at the same rate.

Natural gas in Alberta is used principally for space heating and production of petrochemicals. Reserves are estimated to last 20 years at our current rate of use, or 1.78 trillion cubic metres.

The main constituent of natural gas is methane, with minor amounts of other compounds such as ethane, propane and butane. Because natural gas is an odourless gas, an artificial scent is added for domestic use so that leaks can be detected. Natural gas may also contain hydrogen sulphide, which is extremely poisonous and corrosive, and must be removed before entering the pipeline. This hydrogen sulphide is then converted to elemental sulphur, which is used mainly in fertilizer. Only 11% of the elemental sulphur remains in Canada; the rest is exported.

Oil and natural gas provide the raw material, or feedstock, for Alberta's growing petrochemical industry. Petroleum is made of hydrocarbon molecules; that is, long-chain molecules in which atoms of carbon are combined with atoms of hydrogen. These combinations can be broken and then recombined in hundreds of different ways, and each new combination is a new chemical with its own structure and physical properties. Some of the products made from these chemicals include fabrics, plastic sunglasses, computer disks, long-playing records, movie film, mattresses, transparent tape, bikinis, insecticides, antibiotics, sponges, deodorant, pacifiers, parachutes, heart valves, zippers, laxatives, and simulated cream. See Figure 4. Not only are petroleum products used to power our vehicles, they are used to make wax, asphalt, greases and lubricants. We also wear, eat, use, and throw out oil and its products. In our rush to consume oil and other sources of energy, we lose track of the objective of how that energy should be used.



PETROCHEMICAL PRODUCTS
FIGURE 4

Two hundred fifty litres (250 L) of oil will make:

13 plastic garbage cans, or
40 plastic buckets, or
46 sweaters, or
11 blankets (100% acrylic), or
2 automobile tires, or
27 bicycle tires, or
8 truck tire tubes, or
35 bicycle tire tubes, or
910 pairs of nylon pantyhose, or
9 television cabinets, or
350 m of home water pipe, or
805 m^2 of plastic sheet, or

... enough fuel to heat an average house for 30 days!

To put the value of natural gas into perspective, the average annual space-heating cost for schools in Alberta, using natural gas, is $16,400.

The **oil sands** deposits in Alberta contain amazing amounts of recoverable petroleum. The Canadian native population were the first to use the oil sands, to waterproof the seams of birchbark canoes. The first Europeans to explore the region were intrigued by the outcroppings of oil sands.

The history of the oil sands is a story of repeated attempts and failures to find a practical method of extraction and separation. Mining of the oil sands started near Fort McMurray as early as 1968. Improvements in the process are continuing, but no magical breakthroughs are anticipated. It is tantalizing to realize that a further immense amount of petroleum is still available if only an easy, inexpensive way can be found to separate the petroleum from the sand. Oil from the oil sands continues to be expensive to produce, but the challenge of recovering its reserves makes it one of the truly exciting frontiers in Canadian science and technology.

Another largely-untapped source of oil reserves are the "heavy oil" deposits. In Alberta, there are vast reserves in the Lloydminster/Cold Lake and Peace River areas. Current extraction methods include techniques such as injecting steam, or by in-situ combustion (heating the oil by burning a small part of it underground).

III. NUCLEAR ENERGY - The raw energy source for nuclear power generation is uranium. Canada, especially in Ontario and northern Saskatchewan, is one of the leading uranium producers and exporters in the Western world.

The significant difference between uranium and other elements is the relative instability of the uranium nucleus. This instability results in the spontaneous emission of subatomic particles from the nucleus through a process known as radioactivity. Radioactivity can be harmful at some levels, but background radiation is everywhere, and all humans are exposed to it, so it is impossible to have a control population (with no exposure) to test what levels are "safe". In some areas of the world, people live in conditions with background levels fifteen times higher than those experienced in most areas in Canada, so we know that the human body can tolerate some undetermined level higher than that which occurs from natural sources.

The process of obtaining energy from uranium in a nuclear reactor is quite different from the spontaneous process described above. Neutrons are brought into collision with the nucleus of an uranium atom, causing the atom to split. This process, known as **fission**, produces two or more highly

radioactive elements, along with some free neutrons and enormous quantities of heat. See Figure 5. The free neutrons may induce fission in other uranium atoms, leading to a chain reaction. The heat created is used to make steam, which in turn drives turbines to produce electricity. A reactor is the means through which the right kind of neutrons are produced to cause uranium atoms to split.

The generation of electricity by the fission process is being widely implemented despite the high capital costs required. The **CANDU** reactor (**CAN**ada **D**euterium **U**ranium reactor) has gained praise for its remarkable performance record for economy, safety, and reliability. There are currently twenty-two large CANDUs in Canada, twenty of them being in Ontario. This technology is also exported; nine CANDUs and seven power reactors have been sold internationally.

There are two isotopes of uranium - uranium-238 and uranium-235. The least plentiful of these, ^{235}U, is the isotope needed for reactor fuel. Therefore, raw uranium from mines must be refined to produce material with a high ^{235}U content. Curiously, many coal deposits are found in areas where uranium deposits occur as well. As a result, most coal contains traces of radioactive elements which are released when burned. Mining for uranium began in earnest in 1953. In western Canada, most of the uranium is presently mined in northern Saskatchewan where exceptionally high-grade deposits have been found, and other major deposits are mined in the Blind River and Bancroft regions of Ontario.

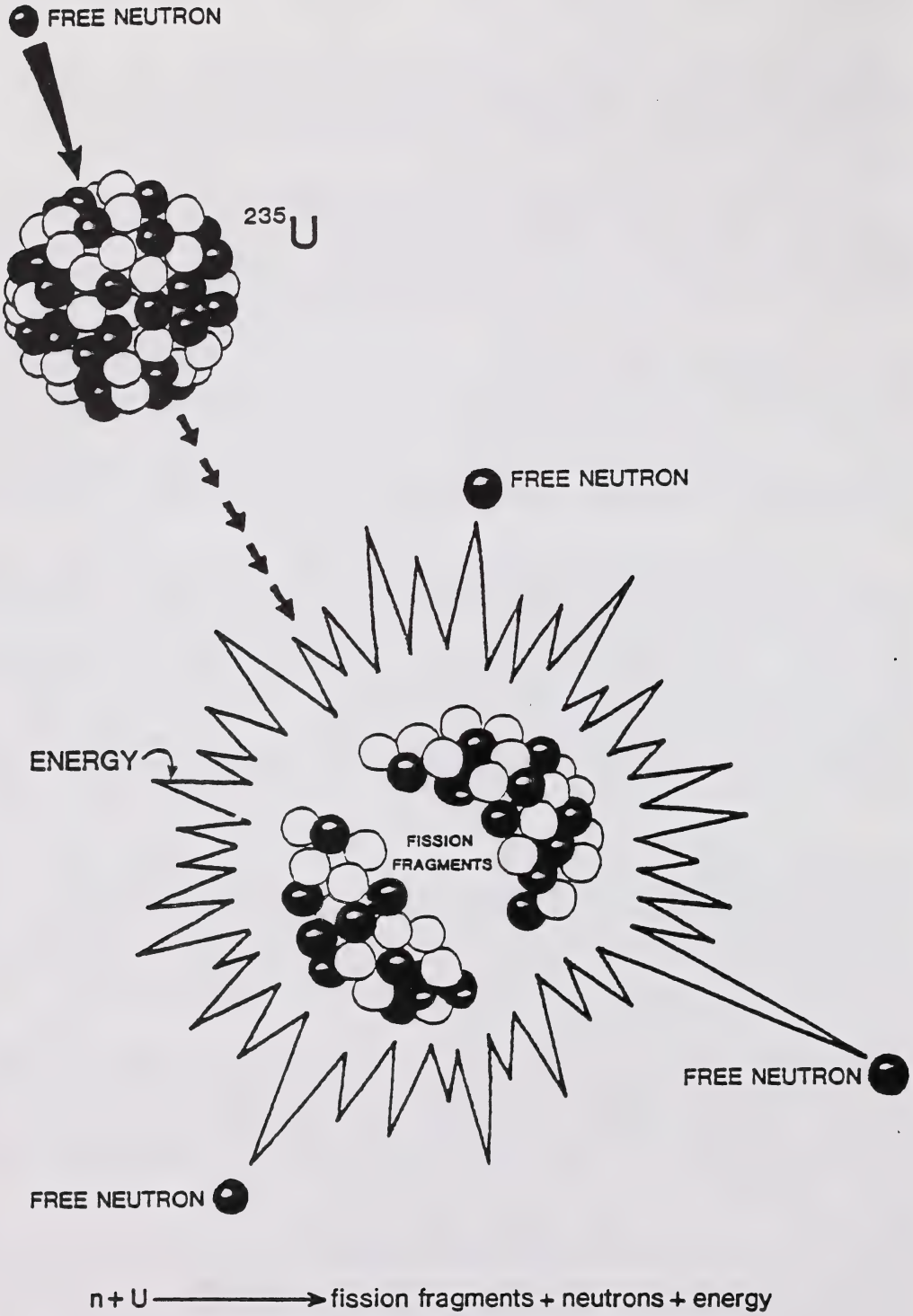
One of the most controversial issues in the nuclear energy debate is the problem of waste storage. Cesium-137 and strontium-90, both biologically harmful, need hundreds of years to decay to a harmless level; highly dangerous plutonium-239 requires thousands of years. In Canada, most of the wastes are simply stored. Machines pluck spent fuel bundles out of the pressure tubes and send them through an underground tunnel into a concrete water bay which resembles an indoor swimming pool. There, with water shielding the radiation, they cool off. Current technology requires that these bundles be stored in these underground water bays, as a temporary measure. To give an example of the limitations of storage, one facility in Ontario can continue storage for only another 11 years. There is now no practical method for storage or disposal of wastes, but research in this area is ongoing.

Perhaps the greatest peril of nuclear energy use is the so-called plutonium curse. Plutonium is a by-product of nuclear fission. The amount of energy remaining in spent fuel has a potential energy yield nearly equal to that of the original uranium. In the future, energy conservation policies will probably dictate that it be recycled. Moreover, a great deal of energy remains in the spent rods. But plutonium is also used to manufacture atomic weapons. Many fear that as supplies of extracted plutonium increase, there will be constant danger of theft, and many do not feel convinced of the safety of nuclear power, because of the danger to the environment, and the loss of health and lives caused by dramatic nuclear reactor accidents.

Another issue in the nuclear debate is the problem of security - not only of plutonium storage - but national security in the case of war. Nuclear power plants operate from centralized locations. Consider the far-reaching effects, if a power plant which powered all of Toronto, for example, were destroyed. Not only is there the possibility of disastrous radiation leaks, but one of the main headquarters of industry, government, and the military would be without power and be rendered virtually immobile.

Nuclear power is not yet an issue in Alberta as we do not use it for power generation. However, it is used elsewhere in Canada. Ontario currently has five plants in operation with more under construction, and New Brunswick has one operating nuclear power plant. Many countries in the world, very notably France, are becoming dependent upon nuclear energy, despite operating costs and the extremely high capital cost (over $1 billion per plant).

Nuclear fusion can best be described as the opposite of fission. In a fusion reaction, energy is released by combining two particles - generally hydrogen isotopes - to produce energy. The amount



THE FISSION REACTION
FIGURE 5

of energy produced in a fusion reaction is impressive because it is considerably greater than that produced in a fission reaction. It also has the advantage of being "cleaner", that is, the waste products are not as damaging to the environment.

Fusion is the energy mechanism which produces the energy in stars such as our sun. A graphic demonstration of the potential of this type of energy is the power produced in a hydrogen bomb. However, the energy liberated from the explosion of a hydrogen bomb is almost impossible to contain in a controlled environment. Therefore, the fusion process presents a great challenge to be overcome before it can be used as a feasible source of energy generation. With present technology, the temperatures required to sustain a fusion reaction cannot be maintained. If the obstacles can be overcome, we would have an almost limitless supply of energy production, because of the abundance of naturally-occurring hydrogen in the universe.

Currently, Quebec and the European Community are working together to develop hydrogen as a fuel as a replacement for carbon-containing fuels.

Cold fusion of heavy water (deuterium) nuclei in palladium electrodes has been attempted and purportedly achieved, but is still at the experimental stage. Its viability is still under investigation, and until the process is verified and practical generators developed, its feasibility as a power source is several decades away. Eventual success of this low-cost, clean energy source could rival any other existing or past energy source, and would rank it as one of the greatest scientific achievements ever.

CHAPTER 2

RENEWABLE ENERGY SOURCES

Solar energy, and other renewable energy sources, hold the key to the energy future. Most of these resources are available free, but there is usually a cost in equipment for converting them to usable energy. The technology to use them for energy is available now. Currently, 19% of Canada's energy demand is supplied by the renewable energy sources of solar, wind, water, geothermal and biomass. Uses of renewables include providing liquid fuels, process heat and electricity. We need a shift in thinking and practice, by the general public, legislators, and the commercial sector.

I. SOLAR ENERGY

The sun is a typical star, which emits energy through nuclear fusion reactions. This energy is emitted in the form of electromagnetic radiation with different wavelengths. The wavelengths vary from gamma rays, with a very small wavelength, to visible light, to radio waves of a very large wavelength. Ultraviolet radiation, sometimes called heat radiation, is of a slightly longer wavelength than visible light. This type of radiation, which can be felt but not seen, causes sunburn and skin cancer.

The Earth's atmosphere acts as a filter which protects it from getting too much solar radiation. If our planet did not have the kind of atmosphere it does it would not be able to support human life. When the sun's radiant energy travels through the atmosphere, three processes occur; absorption, reflection and transmission. **Absorption** of ultra-violet radiation takes place in the upper atmosphere by ozone, oxygen and nitrogen. Infrared radiation is absorbed throughout the atmosphere by carbon dioxide and water. **Reflection** of visible radiation occurs in the lower layers of the atmosphere. It is reflected by clouds, and throughout the atmosphere by dust particles. Reflection can also occur at the Earth's surface by snow and water, which may be absorbed in the air, reflected in the atmosphere, or leave the atmosphere and be reflected out into space.

The greenhouse effect is what keeps the Earth's surface at a consistently warm temperature. The greenhouse gases in the atmosphere let through most of the incoming short-wave solar energy, but traps and retains much of the long-wave energy that the Earth radiates out towards space. The greenhouse effect has recently been discussed in negative terms, as the concentration of greenhouse gases has been increasing, and increasing the amount of solar energy trapped in the atmosphere. In fact the greenhouse effect is necessary for life to exist on our planet. For a further discussion of the greenhouse effect, refer to Chapter 5.

The sun has the potential to supply vast amounts of energy. Scientists estimate that four million tonnes of hydrogen are changed to solar energy each second. Of this, less than one billionth or eighty billion megajoules per second of energy reach the earth from the sun. If we were able to collect all the solar energy that strikes the earth's surface in a fifteen-minute period, we would have an amount equivalent to all the electrical energy used throughout the world in a full year. In a three-month period, the amount of solar energy that strikes the earth is equal to the energy contained in the total world reserves of non-renewable energy. With this vast potential, it is clear that solar energy could meet our present and future energy needs. First, however, much research is needed to solve two problems:

1. developing technology to collect and store solar energy, and
2. lowering the cost of this technology.

In one way or another, all our energy has been derived from the sun. Some has been made into fossil fuels (see Chapter 1) - energy which is valuable, but once used is gone forever. With rising

fuel costs, researchers are looking for ways to reduce our dependence on these non-renewable energy sources and technological advances are increasing rapidly.

Approximately 12% of Canada's space heating requirement is provided by solar energy. Over 50% of residential lighting requirements are provided by the sun. But this is mostly by accident - windows are usually included in a home design for internal and external vision, not specifically for solar collection.

Solar energy will be commonly used only when the capital investment required can be reduced, and when it is competitive with other forms of energy. Also, if the general public had a greater awareness of the potential of solar energy, they might implement it more widely in their daily lives.

Variation of Solar Radiation

Not all of the sun's energy reaches the earth. About 30% of the energy is reflected back into space, 23% is used in the water cycle of precipitation, and 47% is absorbed as heat in oceans, land and air. Although not all of the sun's energy can reach us, it still has vast potential. Indeed, it can supply more than we could ever use, if we had the proper technology.

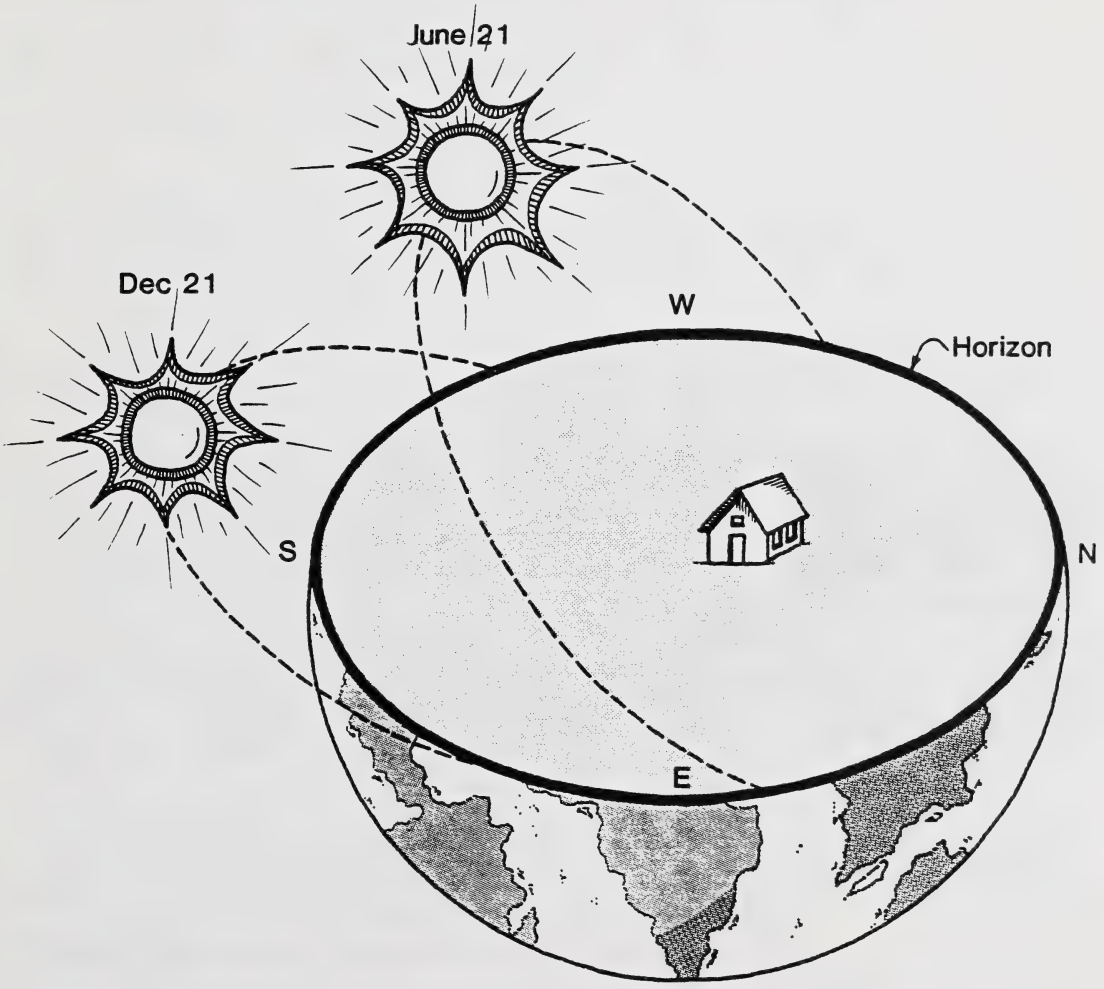
Geography and climate affect the usable solar radiation at any location. Although the amount of solar energy radiated to the earth is very constant, it is reduced by atmospheric reflection and absorption, cloud cover, and albedo of the earth's surface (radiation reflected from the surface of the earth).

The angle at which the sun strikes the planet at any point varies throughout the year and during the day, because of the tilt and rotation of the earth. (See Figure 6.) The nearer to the equator, the more consistent the amount of sunshine received. In Alberta, because we are north of the equator, we receive less solar energy in the winter than we do in the summer. In fact, Alberta annually receives roughly 80% as much solar energy as Florida. However, the solar energy received on a winter day is only one quarter that received on a summer day. The seasonal imbalance that gives us winter also makes solar energy scarce when we need it the most! At the poles, there are even more drastic variations in the amount of sun; the "Land of the Midnight Sun" is so called because during the summer, the northern areas have daylight almost around the clock, whereas in the winter the area is almost constantly in semi-darkness.

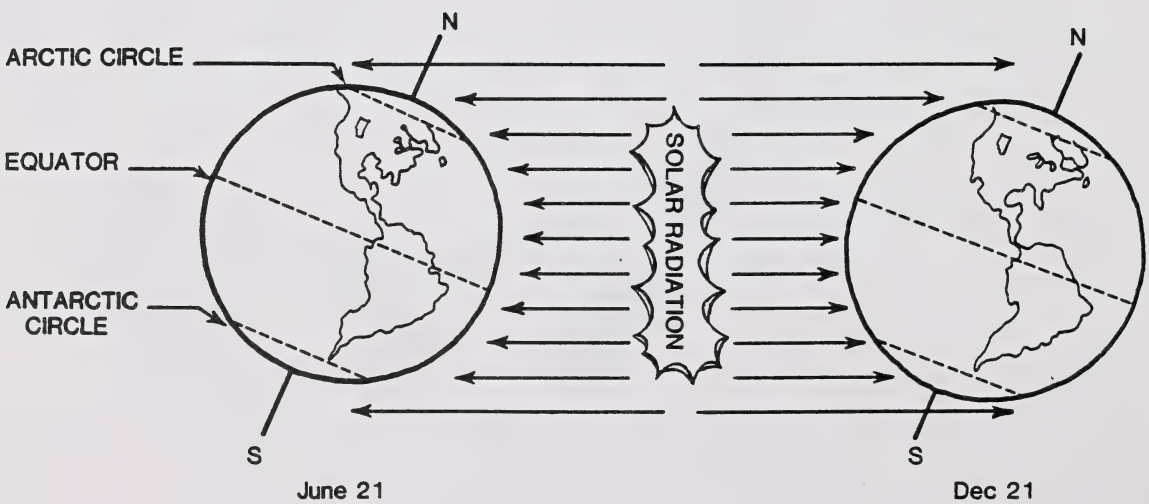
Because the angle of the sun varies, this has impacts on the design and use of solar technology. In home design in Alberta, windows should be placed to the south as the sun is almost always to our south. For devices that collect solar energy, maximum exposure to the sun can be ensured with a system that can be adjusted or tilted to be most directly in line with the sun's rays.

A. SOLAR TECHNOLOGY

History of Solar Energy Use - Since the beginning of history, the sun has been recognized as a source of heat and light, worshipped as a god, and both feared and respected. In 212 B.C., the Greek Archimedes used the concentrated heat off mirrors to destroy a Roman fleet in the harbour of Syracuse in Sicily by setting fire to the wooden ships. This story was proven true by the French Count George Buffon in 1747, when he set fire to a woodpile 60 meters away using a number of small mirrors. Later, enlightened thinkers began to realize how the sun's energy could be put to use. Socrates recognized that the sun could be used to heat homes, and the Romans were the first to use glass in windows to improve the use of solar radiation.During the Renaissance, some scientists used solar devices to burn substances, to raise the temperature of water, and to heat or melt metals. The



VARIATION OF SOLAR PATHLENGTH WITH TIME OF YEAR
(LATITUDE 49° NORTH)
FIGURE 6



AVAILABILITY OF SOLAR RADIATION IS AFFECTED BY THE TILT OF THE EARTH
FIGURE 7

monarchs of Europe in the 15th and 16th centuries popularized greenhouses, and in North America, the Navaho Indians lived in solar-heated caverns.

Antoine Lavoisier, the founder of modern chemistry, discovered in 1714 that oxygen was the gas produced by a sun lens directed onto mercuric oxide. He also used a lens system to obtain temperatures of up to 1760 °C. Later, in 1839, A.E. Becquerel was able to generate an electric current using sunlight. In 1878, Abel Pifre used parabolic reflectors to heat water to run a steam engine, which he used to power a printing press. At the Paris Exhibition, he demonstrated his solar-powered printing press by printing a newspaper entitled "Le Soleil" - The Sun.

1. ELECTRICITY FROM SOLAR ENERGY

How a Photovoltaic Cell works

Photovoltaic cells convert light directly into electricity with no pollution, no noise, and no movement as shown in Figure 8. Just as sunlight can be used to power a small pocket calculator, it can produce electricity on a larger scale. Unfortunately, at current technology, photovoltaic cells are not practical because of their high cost for large scale use when electricity is available from the utility grid cheaper and easier.

Solar cells are made using special substances, such as silicon. Silicon is the second most abundant element on earth, and therefore is readily available and relatively inexpensive, however, for the manufacture of photovoltaic cells, ultra-pure silicon is required, which is very expensive.

The manufacture of photovoltaic cells starts with high-grade silicon, which can be made from sand. "Boules" of silicon, which are grown from molten silicon must be sliced into very thin wafers. Then, the surface of the wafer is smoothed by chemical etching or mechanical polishing, and the wafers must then be heated in a furnace. In the next step, thin metal wires are attached to the front and back surfaces of the cells to conduct away the electric current it generates. Finally, a non-reflecting coating is added.

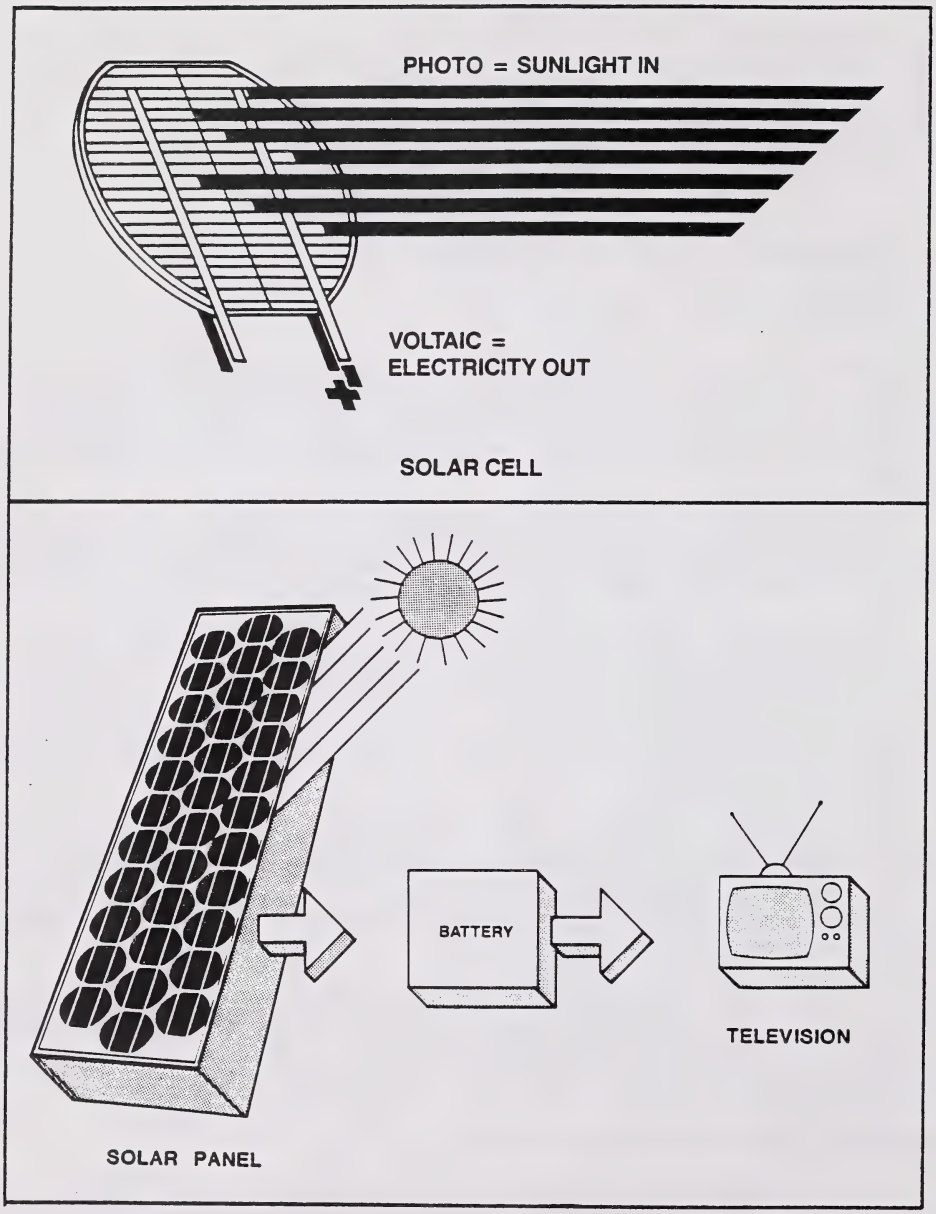
When the cell is in darkness, no current flows through it. But when the sun's radiant energy strikes the cell, the electrons inside become highly charged and it releases an electron from a silicon atom. The electron then moves to the more positively charged layer and then to a metal "finger" or node implanted in the cell. This stream of electrons is a current, so enough cells can produce a usable amount of electricity.

The amount of current produced by the photo cell is directly related to the intensity of the light striking the cell's surface. This is why large-scale photovoltaic arrays are fitted with "trackers" which always face the cells directly into the sun's path. Energy cannot be collected at night, but daytime energy can be stored in batteries.

Electricity Generated by Photovoltaic Cells

Photovoltaic panels are available in different voltages for different applications. Just a few of them in series can light a light bulb. Approximately five can be strung together to make a nickel-cadmium battery charger. Most often, cells are put together in panels for other applications as described later. These panels are made to different sizes and can be quite portable.

The efficiency of a solar panel is related to temperature. In summer, or times of high temperature, the panel operates less efficiently than at times of lower temperatures. Therefore, although it may seem that solar technologies would work best in summer because it is sunnier, in actuality they are at least as effective in the winter.



PHOTOVOLTAIC CELLS
FIGURE 8

Solar (photovoltaic) cells were first used by the U.S. space program on satellites in the late 1950s. At that time, a photovoltaic system just large enough to keep a 100-watt bulb burning would cost more than $1 million. Solar photovoltaics still cannot compete with electricity generated by fossil fuels or nuclear power, however, the price is decreasing as the technology matures.

Solar cells are being used in northern Canada to produce electricity competitively with diesel systems. They are also useful for mountaintop communication systems. In some very remote locations, when access to the utility grid is not practical, some homeowners have installed solar panels on their homes, however, it cannot provide the amount of electricity we are used to having at our disposal. The power produced by photovoltaics is generally 12-volt, therefore appliances must be of 12-volt variety, or the power must be converted from DC to AC if the original appliances are to be used. Other uses for solar electricity include as floating "buoys" in the ocean to collect weather and oceanographic data which is transmitted via satellite, to power railway crossing signals and railway car tail markers, to power telephones, and to provide electricity for use on boats and campers.

Water Pumping using Photovoltaic Cells

Solar water pumping devices were initially developed for use in third world countries, to take advantage of the abundance of sunshine. The electricity generated by the solar cells powers an attached pump. The pump then draws the water out of the well to the surface, into irrigation ditches or dugouts. Because they have no moving parts, they require little maintenance, and they are very transportable. Some of these units can be easily transported by a man or towed by a mule or other animal. The panels fold together to increase portability, and to protect the panels from damage during storms.

Solar water pumps are becoming more popular in Alberta. They have been tested at the Wind Test Site in Lethbridge, and data is available to farmers to document their efficiency and performance. They generally perform more reliably than wind-pumping systems, and require little or no maintenance. However, they cost more than wind systems, but the price will continue to decrease as improvements are made, and as production quantity is increased.

The greatest advantage of solar-powered water pumps over wind-powered systems, is that they work best when the water is most needed. In the hottest period of an Alberta summer, there is very little wind and precipitation. Water is critically needed for livestock and other farm uses, and because there is no wind, a windmill will not be able to pump the water required. However, this is the time of the greatest amount of sunshine, and a solar water pump can function reliably, without noise, without breakdown, as long as pumping is required.

Many Albertans have been involved in the design, manufacture, testing and marketing of solar water pumping. Great potential exists in this field, both domestically and for export.

Solar Cars

Some solar-powered cars have been developed which are equipped with fairly large solar panels which convert sunlight into electricity to power the car. The electricity is stored in batteries inside the car. These types of cars are only at the experimental stage, but have aroused public interest because of trans-continental solar car races. For example, the General Motors $8 million Sunraycer won a recent trans-Australian solar car race at an average speed of 70 km/h over 3 120 km.

Because of the high cost, these are not yet practical for consumer use. They cannot be used at night or during cloudy periods, and will not reach top speeds unless in an extremely sunny area

as it is difficult to store the energy effectively in batteries. A new battery is being developed in Switzerland and should be available in 1991. Switzerland is also leading the way in the development of solar electric cars. 150 of these cars are now legally operating on their roads.

2. THERMAL HEAT FROM SOLAR ENERGY

Solar Water Heaters

Water can be heated by solar energy using a solar collector. The heated water is stored in a tank and can be used at any time to heat the air for a building, or for heating water for bathing and for washing dishes or clothes. A small, simple unit can provide up to 40% of a normal household's hot water requirements, with no service charges or fuel costs.

To heat water, the solar collectors are usually mounted on the roof of a building. Pipes behind the panels circulate water, which is heated by the solar energy collected by the panels. The heated water can then be used for several purposes. For space heating, the heated water is either circulated through baseboards or pipes in the floor, or to heat air in a forced-air system. For domestic water use, the heated water is stored in the hot water tank for storage until required. It is important to note, however, that any type of solar water heating system requires a conventional system, using electricity or natural gas, for backup during cloudy periods and at night.

Solar Furnaces

When the heat of the sun is concentrated in solar furnaces, it can produce extremely high temperatures. Mirrors track the sun, and direct the sun's rays into a parabolic reflector which then concentrates the rays onto a target area. Small solar furnaces, reaching temperatures of about 1000 °C are used for soldering, jewellery-making, and for heating kilns. Large-scale solar furnaces are now used in many different countries, but not currently in Canada. They can be used to produce the extremely high temperatures required for industrial processes such as steel production.

Passive Solar Homes

The concept of using solar energy for heating homes is not new, and involves simple, common-sense design techniques.

> *"Now in houses with a south aspect, the Sun's rays penetrate into the porticoes in winter, but in summer the path of the Sun is right over our heads and above the roof, so that there is shade.*
>
> *If, then, this is the best arrangement, we should build the south side loftier to get winter Sun and the north side lower to keep out the cold winds."*
>
> *Socrates, c. 4th Century, B.C.*

A home with passive solar features uses the sun's energy for space heating, and should be specially designed to take into consideration climate and latitude. A passive solar home is one in which the means to collect solar energy is part of the design of the home, and non-mechanical.

The starting point for passive solar design is an energy efficient home. Heat produced by solar energy can make a significant contribution to a home's space heating needs and reduces the amount of heat required from other sources. Improving the energy efficiency of a home also makes economic

sense; it is the cheapest first step to take to lower utility bills. An energy efficient home, in new construction, usually means a well-sealed building with balanced, centralized ventilation and insulation levels of RSI 5 to 5.25 (R28 to 30) in the walls, RSI 7 to 8.75 (R40 to 50) in the ceiling, and RSI 3.5 (R20) in the basement.

Most average homes are imperfect shells, inadequately insulated, not taking full advantage of the sun as a free heating source, improperly sealed, with an inefficient heating system. All of these elements together provide for something like a "leaky bucket" (see Figure 9). Energy efficiency measures will help "plug the holes", and take full advantage of solar energy to provide heat.

A home designed for the sun has lower utility bills than other homes and lots of daylight. Many passive solar homes in Alberta are heated almost exclusively with the sun. Taking advantage of the sun, however, is only one of many priorities when designing or renovating a home. A home should be most of all a comfortable place to live. Therefore, solar features should be adapted to a satisfactory house plan.

BASIC ELEMENTS OF PASSIVE SOLAR HEATING

Definitions

Passive solar heating has three key elements; a way to capture heat from the sun, a way to distribute the heat, and a way to store it if necessary. In **passive solar heating**, these elements are part of the home and function without mechanical assistance. Fans and controls can enhance the performance of a passively heated space, but they are not necessary.

Design Considerations For Alberta

It is impossible to design a "generic" or "all-purpose" solar home for Alberta, or for anywhere in the world. Well-designed passive solar features take into account all the details of the site and house plan; for example, the windbreaks, the heat-absorbing characteristics of building materials, the solar gains through windows on an hour-by-hour basis, and passageways and obstacles to air movement.

The process of designing passive solar features falls into three steps; getting sunlight into the house so that it can be used for heat, distributing the heat throughout the house, and incorporating materials to store heat to be re-radiated later, if necessary. A lot which faces north or south is best so that the solar side of the house can be oriented to the sun, and not facing other houses or buildings which could block the sun. Most of the glass in a home should face south to absorb as much sun as possible during the winter months when the sun is low on the south horizon. Shade trees will help prevent overheating in summer. Figure 10 demonstrates how landscaping can help enhance energy efficiency.

Windows are one of the most important considerations in passive solar design. Their orientation, number and type of panes, size, shading and slope all affect the amount of heat which will be gained from the sun.Single pane windows admit the most light but have the lowest insulation value (see Figure 12). In our climate, double-pane glass is a minimum to control heat loss. Insulation value for windows is measured in RSI or R values, as are other construction materials.

The sun is an important light source as well as heat source. If most of the windows in a home face one direction, this will affect the amount of daylight in the rest of the home. Different window styles, such as clerestory windows, skylights, and dormer windows are one way to increase daylight. If they face south, they can increase daylight with less heat loss. Clerestory windows are better than

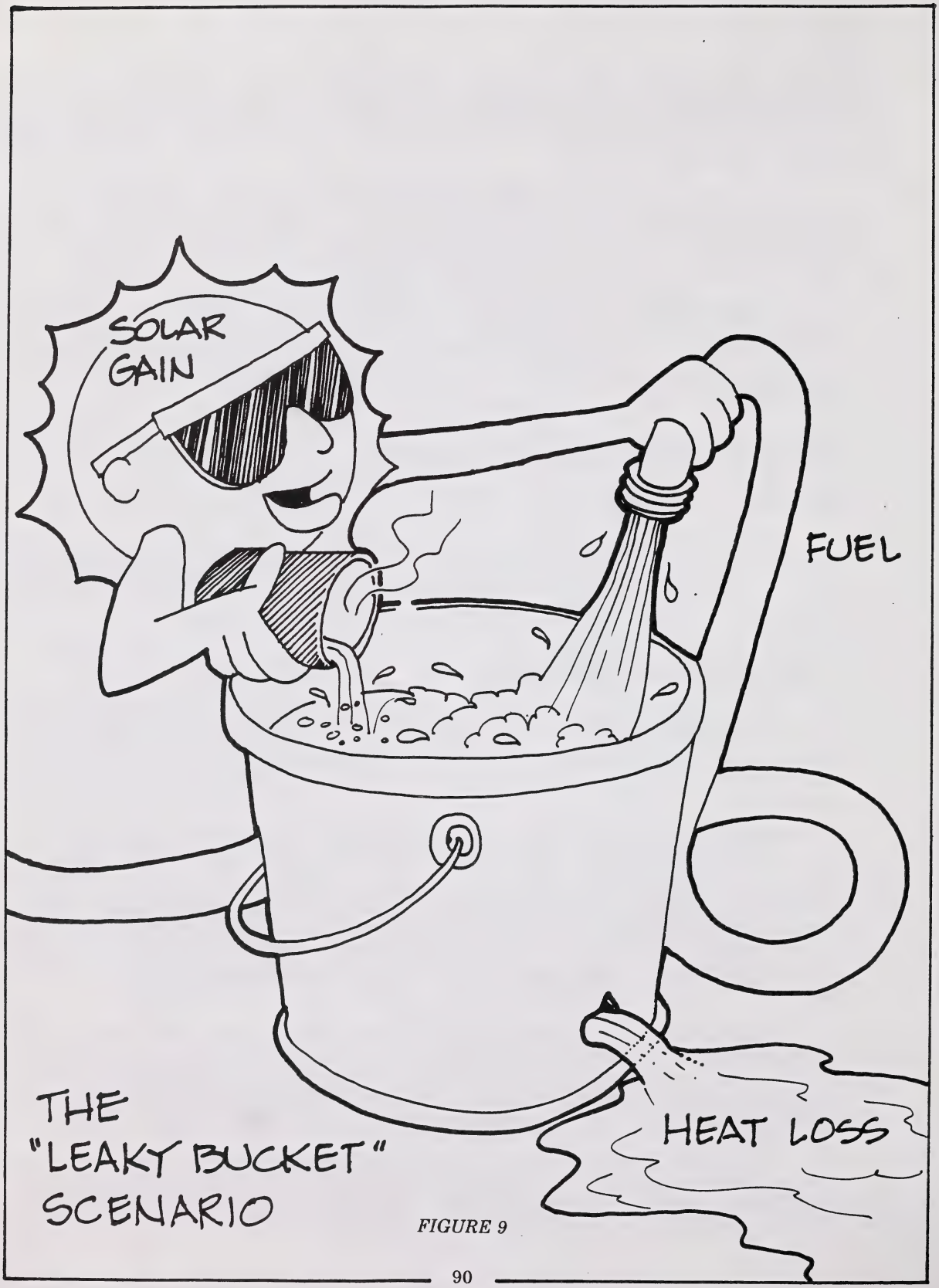


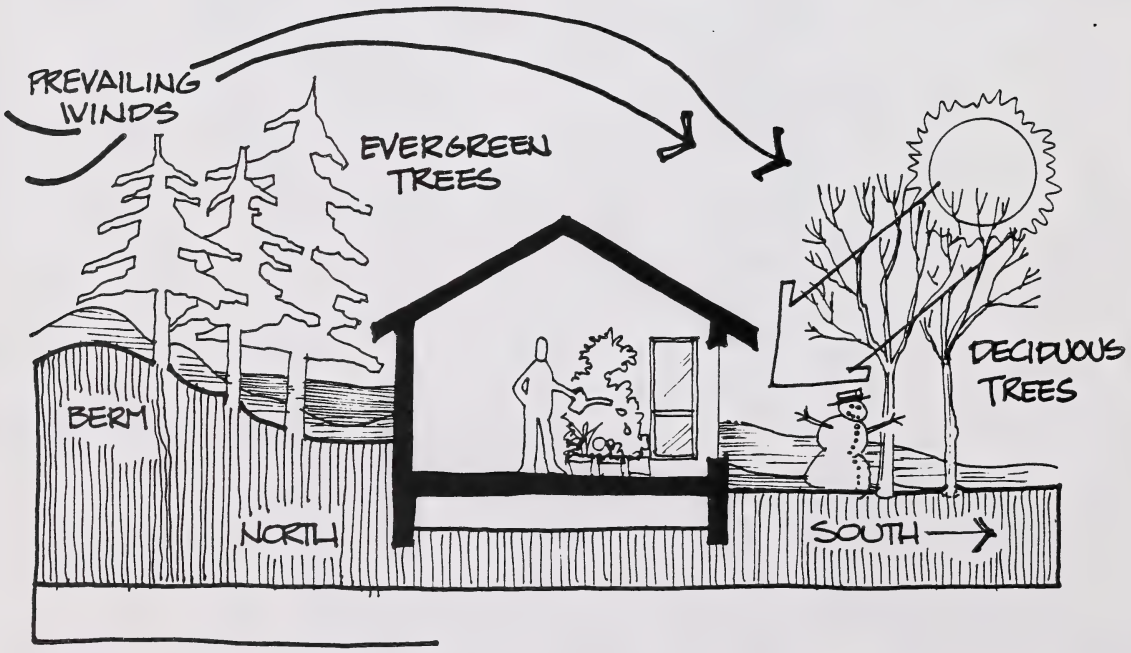
FIGURE 9

skylights because they let in more winter sun and are easier to shade in the summer. South-facing skylights can cause overheating in summer and are very difficult to seal against leaking.

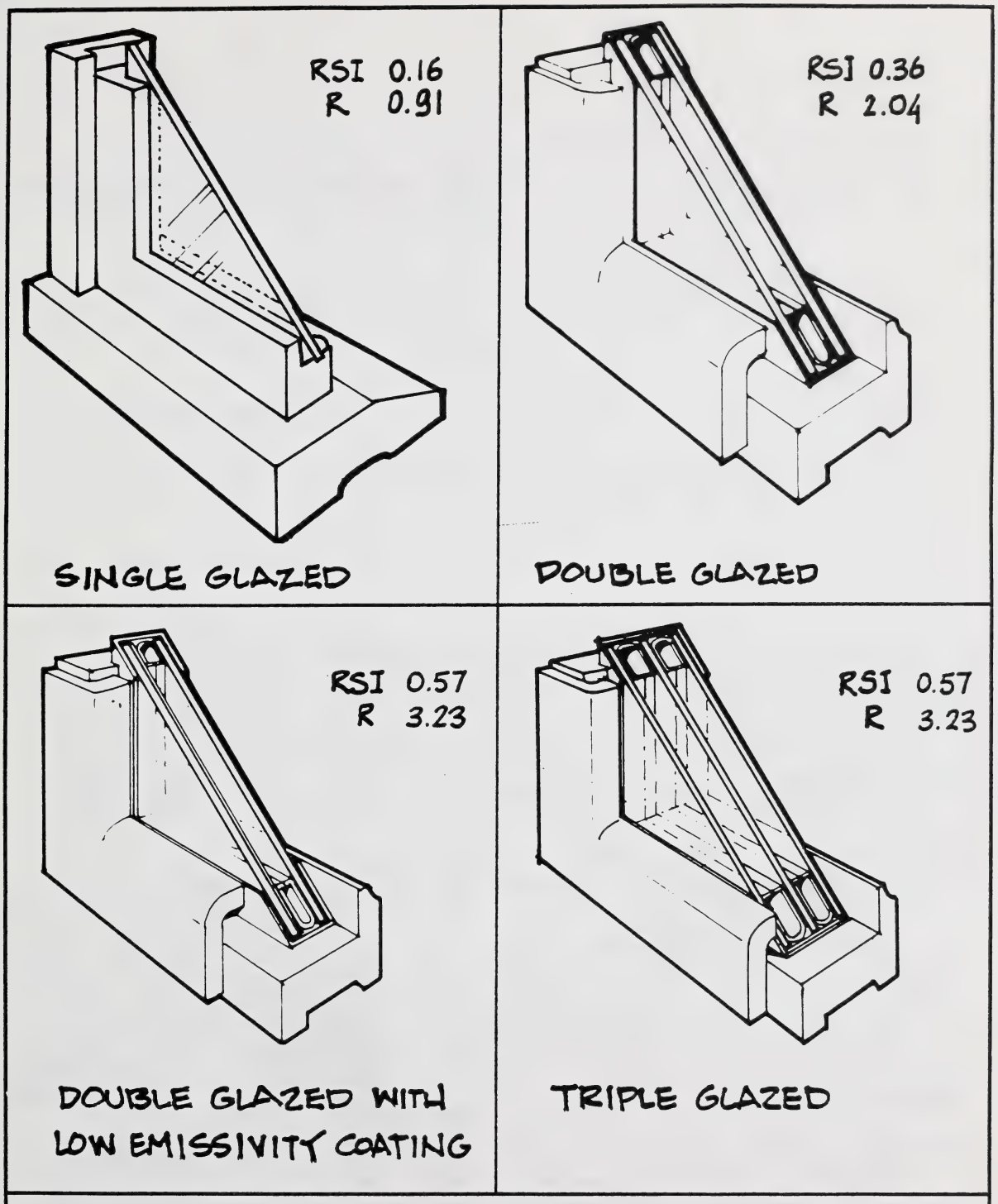
Glass area should not exceed 12 to 15% of the total floor area for an energy efficient Alberta home with triple-paned windows, or 6 to 10% if using double-paned windows. If larger, overheating can occur, and if less than these amounts, not enough heat or light can be captured. Shading provided by overhangs, curtains, awnings and trees can help control overheating in summer, and to allow more sun into the house in the winter.

Air circulation helps to distribute heat in a passive solar home and can be encouraged in the physical layout of the home, and in the design of heating and ventilating systems. An open concept floor plan improves air distribution by allowing air to circulate more freely than in plans divided into many separate rooms. Windows on opposite sides of the house allow cross drafts for cooling from natural breezes in summer.

Heat can be stored by adding thermal mass. Concrete, brick, stone, ceramic tile, water and extra drywall are commonly used for thermal mass. They reduce temperature swings because they can absorb a large amount of heat when their surroundings are hot, and release it when the sun sets and their surroundings cool.

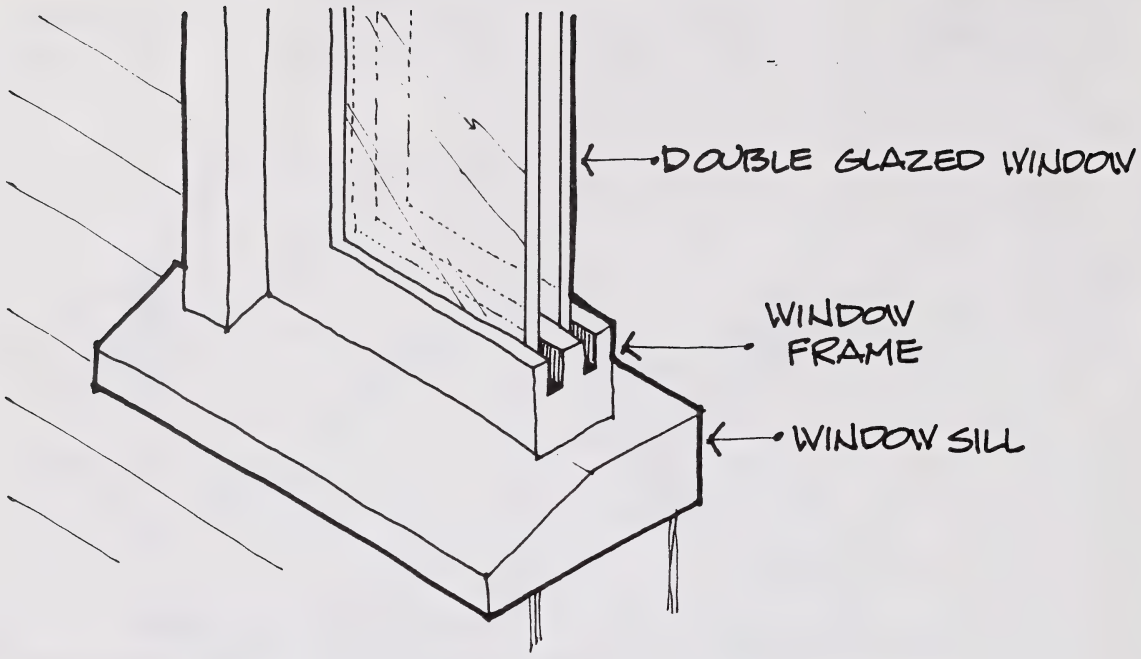


LANDSCAPING TO IMPROVE ENERGY EFFICIENCY
FIGURE 10

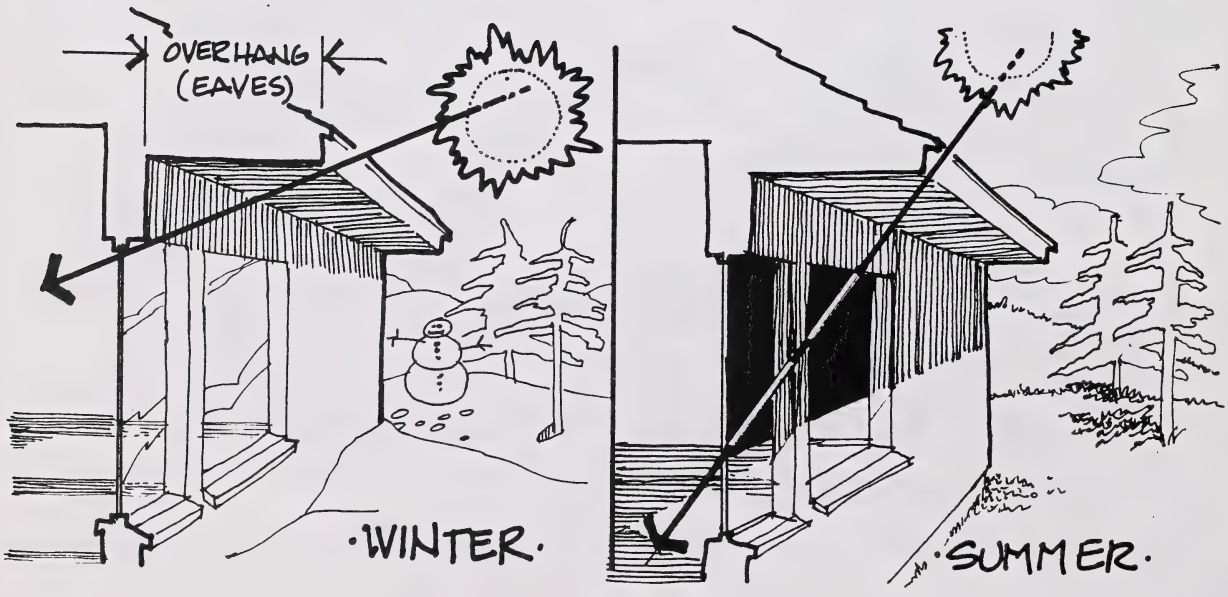


WINDOW GLAZING

FIGURE 11



DOUBLE GLAZED WINDOW
FIGURE 12



OVERHANGS CONTROL ENTRY OF SOLAR RADIATION
FIGURE 13

II. WIND ENERGY

Wind is directly attributable to the sun. Most of the sun's incoming energy is absorbed around the equator and warms air in these areas. As the warm air rises, it is replaced by cooler streams from the poles. Because of the movement of the earth during rotation, the air flow is twisted into counterclockwise circulation patterns in the northern hemisphere. The sun's heat energy has been transformed into energy of motion, or kinetic energy in the wind.

Regionally, wind patterns constantly change because of the effects created by the unequal heating of the earth's surface (such as rock, water, vegetation, etc.), and cloud formations. Areas near large bodies of water generally have more wind due to sea breezes. Mountainous areas also usually have more wind because of the funnelling effects of the mountains.

Wind contains kinetic energy in the form of air molecules in motion. The energy can be harnessed to produce power through the use of wind generators. These machines obtain power from the wind by converting the wind's energy to the rotation of a propeller or blade on a wind machine. Not only is this power free and renewable, it is also enormous. From the amount of global wind energy available, if only 10% were extracted, we could easily meet the world's energy needs from this source alone.

A. WIND TECHNOLOGY

History of Wind Energy Use

Wind has been used for power for centuries. The first wind-driven device, a waterlift, was designed in Persia about 600 B.C. By 200 B.C., this device was improved and designed to grind grain. Advances continued in the Middle East and were spread through the Crusades to Europe during the Middle Ages. The Dutch then adopted the use of wind energy to extensively pump massive amounts of water from low-lying basins for land reclamation. When the steam engine was introduced in the Industrial Revolution, a decline in windmill use began which continued until the mid-twentieth century. The first systems designed to generate electricity were developed in Denmark in the late 19th and early 20th centuries.

Windmills were a common site on Alberta farms from the 1920s up until the 1950s. They were used to pump water and generate electricity; however, once grid electricity was brought widely to rural areas, wind power was replaced by this convenient, reliable, and cheap alternative.

The improvement of wind conversion technology and the increasing costs of electricity are leading to a resurgence of wind's popularity, and it is now being used to generate power in many nations. It can be used in any nation, and for small and large-scale use. In North America, many small, low power units are in use, and there are now a number of large "wind farms" which consist of many windmills on one site generating a large amount of electricity. In southern Alberta, some farmers generate their own electricity using windmills, and sell their excess power to the local utility to reduce their energy costs.

Harnessing the Power of the Wind

Wind power can be used to pump water, and to generate electricity which can be stored for later use or connected to the existing utility grid. It has the potential for both small-scale (home) and large-scale (community) applications, especially in remote areas. The availability of wind varies from region to region. Some regions may have insufficient average wind for economic harnessing, but they may have specific sites that are appropriate.

Wind machines are best used in areas with consistently strong winds. However, it is often economical in remote areas with only moderate winds, because of the costs associated with supplying conventional electricity. In these instances, wind power can compete with electricity from other sources, either from the utility grid or produced by diesel generators.

B. Windmills

The wind's kinetic energy is transferred to mechanical or electrical energy through the blades of a rotor. The rotors of a wind machine turn on an axis, just as the earth does, or a car's wheel. Because the wind's direction and speed change constantly, different designs are used to try to capture as much wind as often as possible. For example, horizontal axis windmills require a rudder to adjust to changes in wind direction. The time that it takes the rudder to re-adjust to changes in wind direction reduces the amount of available wind. Alternatively, vertical axis windmills will operate with very little wind, but often require a separate system to start them up. Windmills must also have automatic shut-offs to prevent damage from high wind speeds.

The electrical energy created by a windmill can be stored in batteries and used later. However, most of these storage systems at present are quite expensive and inefficient. In the future, if better storage methods are developed, wind can be more widely used to generate electricity. Sometimes wind machines are connected with the utility grid so that any surplus electricity is absorbed by the grid system, and the wind machine operator is given credit for this power. In times of low wind speed, electricity can be used from the grid in the conventional way.

Types of Windmills

Small wind energy conversion systems usually consist of a 2- to 6-bladed turbine, rotating on a vertical or horizontal axis; an electrical generator/alternator driven by the turbine, a tower, control panel, and electricity storage (batteries) or utility interconnection hardware.

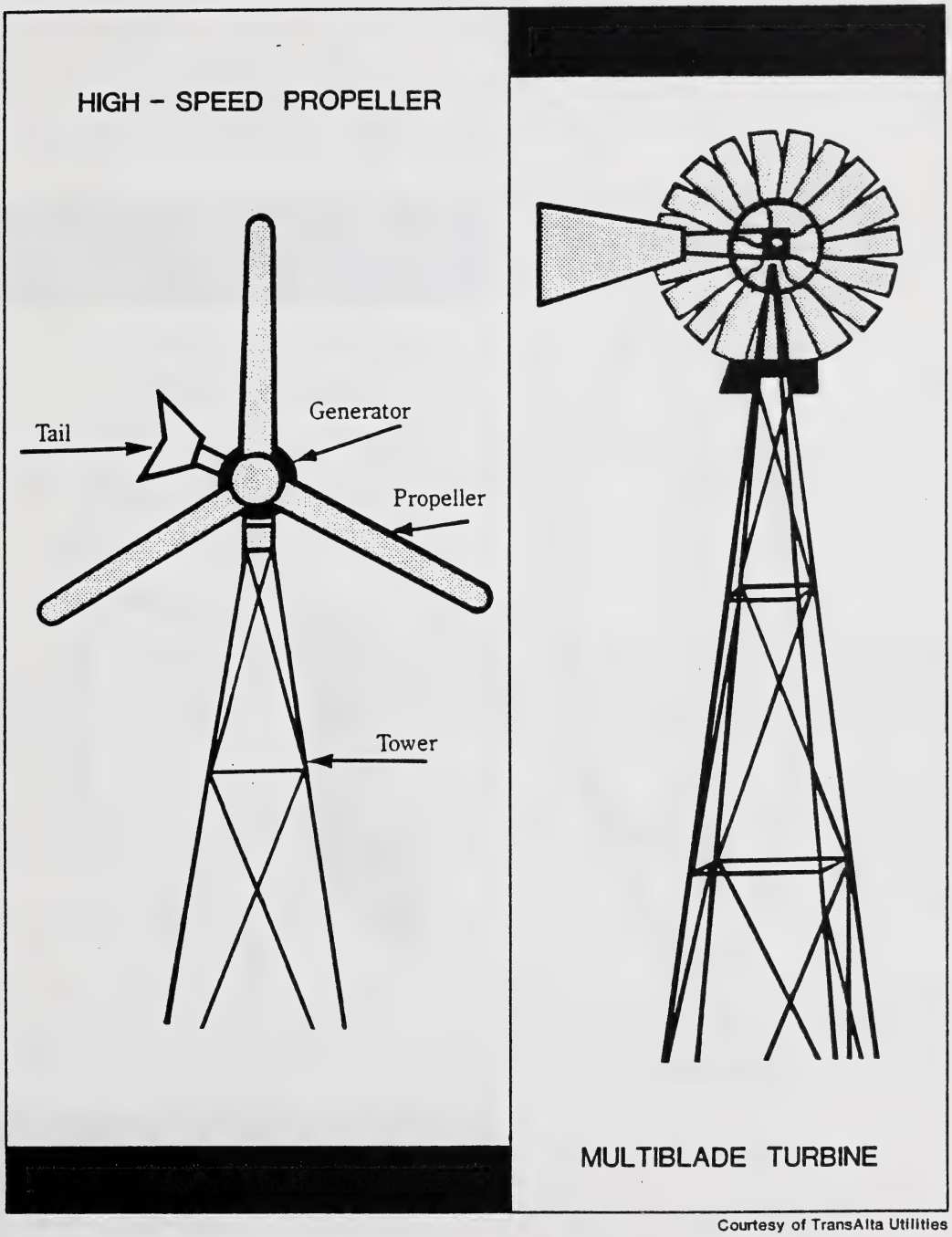
Different types of windmills are used for different purposes. Those with rotors on a horizontal axis, shown in Figure 14, are best suited for small units, and for pumping water. They are designed so that the blades and the turbine turn to face the wind whenever it changes direction. Vertical axis windmills such as the Savonius or Darrieus rotors in Figure 15, are sometimes called "egg-beaters" and usually perform better in areas of higher wind. These windmills have their axis of rotation perpendicular to both the earth's surface and the wind stream. One of the advantages of this simpler design is that they do not require time to respond to a change in the wind direction.

The initial cost of a windmill can be high, ranging from $5,000 for a small machine for pumping water on a farm, to $500,000 or more for very large and sophisticated units. Although they may be expensive, they can compete economically with alternatives, especially in remote areas or where other energy sources are not feasible or appropriate. In energy savings, these systems pay for themselves in a fraction of their lifetime, which can be more than thirty years.

Technology Solving Problems

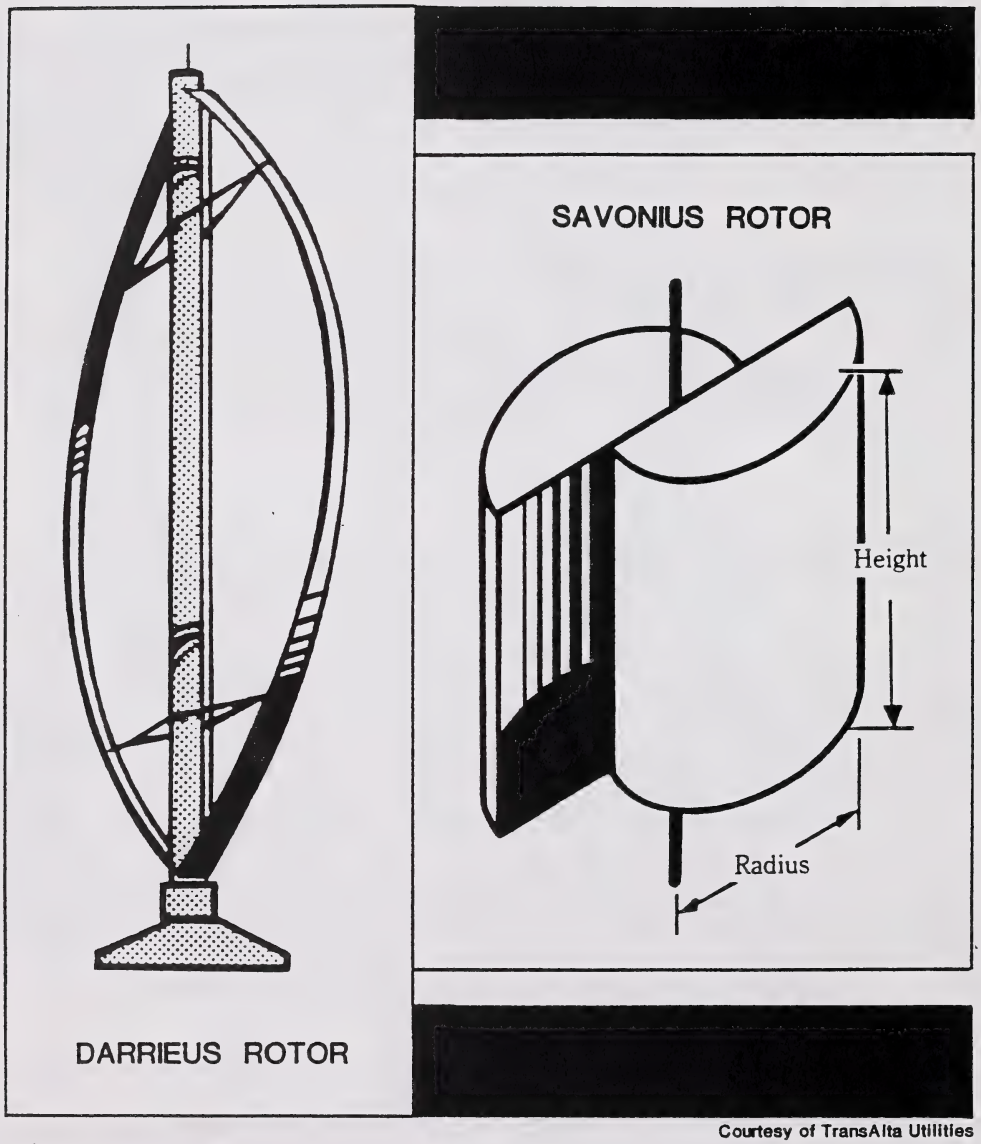
There are some drawbacks to using windpower, which are being addressed in the design and utilization of wind machines.

In the early years of windmill use, one of the problems encountered was adapting to change in wind direction. With the early windmills in Holland, complicated, labour-intensive systems of men turning a large windmill around to face the wind was one solution. With smaller horizontal axis



Courtesy of TransAlta Utilities

HORIZONTAL-AXIS WINDMILLS
FIGURE 14



Courtesy of TransAlta Utilities

VERTICAL-AXIS WINDMILLS
FIGURE 15

windmills, fantails or rudders were added to automatically shift the windmill to face it directly into the wind to gain the maximum amount of energy possible. Time and energy were lost, however, when the windmill swung around, and this brought on the development of the vertical axis windmill. Its shape and orientation face it into the wind at all times. However, they are generally not self-starting as are most horizontal-axis windmills. To compensate for this difficulty, electric motors are sometimes connected to the frame to start rotation.

At one time, windmills had no provision for storage of power. A wind-powered pump would pump when the wind was blowing, at rates varying with the wind speed. This problem also exists for electricity generation because the power coming from the wind generator varies. Electric generation and storage technology has largely eliminated these difficulties. Technology has succeeded in solving both of these problems.

To deal with fluctuating electrical currents, wind generators are now generally equipped with regulators to ensure a steady current flow. The power from a wind generator is supplied in direct current (DC), but most appliances run on alternating current (AC), so inverters are included in the system to convert to AC current. Some appliances are manufactured for DC use, but the selection and availability is generally limited. Alberta has shown leadership in the field of wind energy for water pumping. Not only do we have one of the world's foremost wind test sites in Lethbridge, we also have more installed wind machines than anywhere else in Canada.

Choosing a Site

The most important consideration in siting a windmill is to ensure that the average annual wind speed is sufficient, usually 12 to 14 km/h. If being used to generate electricity, the amount of electricity required must be determined. A storage system should be considered for times of low wind. If feasible, it may be possible to interconnect the wind machine with the utility grid to eliminate the need for storage.

To be most effective, windmills are usually mounted on towers. Because wind speed is affected by hills, trees, other buildings, etc., most towers are usually constructed to be 6 to 10 m higher than any obstructions within a 150 m radius of the mill.

A windmill suitable to the site must be chosen. The rotor and the generator/alternator assembly must be matched to each other, and to fit the needs of the situation.

The best sites are open plains and hilltops where the acceleration effect occurs. Wind speeds are more regular and stronger at higher altitudes, therefore, it is helpful to place it on high ground. Even a small amount of height gained to reach winds of higher speeds will have a great effect - a doubling of the wind speed provides eight times as much power!

Water Pumping with Windmills

Water can be pumped using windmills, either for drainage or irrigation systems, or for livestock. A wind-powered pumping system usually consists of a rotor and a crankshaft, with a mechanical assembly driving a conventional piston pump. The traditional horizontal axis multi-blade turbine has been the most common type of windmill used for pumping water. These windmills are still familiar sights on many Alberta farms, and their popularity is returning.

Wind-Generated Electricity

The mechanical energy in wind can be converted to electrical energy. The wind causes the windmill's blades to revolve, and turn a shaft connected to a generator, which causes the generator to revolve. The revolving generator creates an electric current, which is transferred through the wires of the windmill tower and eventually into the building or house the windmill services.

Wind-powered electric generators are well suited to remote locations which would require expensive hook-up to the utility grid. In these instances, often a wind machine is more cost-effective than paying thousands of dollars just to hook up with the power lines, plus the energy costs involved. The electricity can also be used to heat water for household or farm use, and can also be circulated through a hydronic heating system to heat homes and other buildings.

In Alberta, a number of independent power producers have grouped together to assist in the planning of Alberta's future concerning small power production facilities; centralizing, stabilizing and enhancing the Alberta Interconnected System. In 1985, it became possible for small power producers to hook up with the provincial energy grid to sell their surplus power. There is currently a debate regarding the value of power produced by small independent producers. As more and more wind generators are connected to the grid, their importance will increase as contributors to Alberta's electric energy needs. In a balanced energy future, wind is an environmentally clean alternative which can help to extend the life of fossil fuel supplies by augmenting conventional electricity generation.

III. BIOMASS

Biomass energy is derived originally from the sun. It is the sun's energy, captured by growing plants, and stored in matter that we can use as food or fuel. This can include vegetation (such as mosses, seaweed, peat and wood), garbage, paper, forest wastes (wood chips, deadwood, etc.) and farm waste material (manure, grain wastes, etc.).

Biomass can be turned into gas by cooking-type techniques (heat, steam, pressure and added chemical catalysts) or brewing or fermenting techniques; and it can also be made into liquids for fuel. These energy sources can be used to make plastics, generate electricity, industrial process steam, domestic space heat, and synthetic natural gas and other liquid fuels. In China, biogas digesters and stoves are being used in entire communities which have difficulty obtaining fuelwood because of dwindling local availability. Here in Canada, wood chips are being used for space heating, mostly in industrial settings, in the maritimes.

Currently, biomass is in use in "energy plantations" or farms, where high-energy, high-yield plants are raised specifically for energy production such as for the ethanol component of "Gasohol". Some municipalities recover heat from urban waste incineration to produce energy. Methane generators can be used to provide heat and cooking fuels to offset the use of electricity, natural gas, or wood. The wood industry utilizes its waste products to provide some of their power requirements, reducing the leftover materials from deforestation. Animal manure and human wastes can be digested anaerobically to produce methane gas. Algae harvested from the oceans can also be used in energy production.

In view of depleting resources of fossil fuels, this type of renewable energy has great potential. However, the crops needed for biomass energy production must be grown on arable land, which is already in critically short supply. It is predicted that by the year 2000, the earth will lose another 18% of its arable land, so the question must be debated: "Do we use the land to produce food for the millions of people the world over, or to produce energy for the energy consumers in the industrialized nations?"

A. Wood - The burning of wood supplies heat energy. It is the principal heating and cooking fuel for 80% of people in developing countries, and the primary energy source for nearly half the population of the world. Although wood is technically a renewable energy source as it can be planted and grown again, it takes many years for a tree to reach maturity. This varies according to the variety of tree, but it can generally be considered to be about 30 to 60 years. Wood is also used to a limited degree, for domestic space heating. Figure 16 demonstrates the recent increase in Canada's use as wood for domestic heating. Wood is used not only in the lumber and pulp and paper industries, but also in the manufacture of rayon, cellophane, insulation and shatterproof glass. One cord of wood (a solid stack of 3.6 m^3, or 4 ft x 4 ft x 8 ft) will yield:

7 500 000 toothpicks, or
61 470 envelopes, or
2 700 copies of a 32-page newspaper, or
12 eight-seater dining room tables, or
89 870 sheets of bond paper.

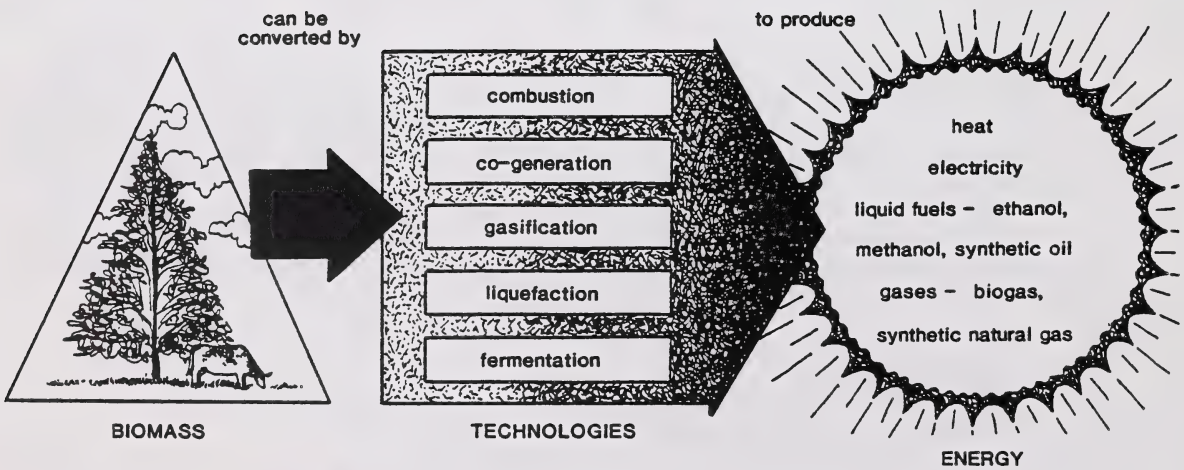
Wood as an energy source is sometimes mentioned as a good alternative fuel, because it is a natural, renewable energy source which is biodegradable and reminiscent of simpler times when people lived in harmony with the earth. It is not a common energy source in Alberta, but the wood is used to make other products. For example, transportation of wood is costly, and the pulp and paper industry is highly energy-intensive. To produce the very white paper we are accustomed to using, bleaches are used extensively, which contain toxics damaging to the environment. The huge machines

CANADA'S FUELWOOD USE FOR RESIDENTIAL SPACE HEATING

Year	TJ[1]	% of total energy [2] use in the year
1977	32,275	0.5
1978	40,590	0.7
1979	44,302	0.7
1980	68,387	1.1
1981	65,527	1.0
1982	98,265	1.7
1983	85,687	1.6

(1) 1 TJ (terajoule) = 1 trillion Joules
(2) Total secondary energy consumption plus total residential firewood.

FIGURE 16



BIOMASS
FIGURE 17

that turn wood into pulp and pulp into paper are powered by electricity. Efforts are being made by the lumber industry to respond to increased operating and energy costs by burning whatever cannot be converted into products, and thus generate much of its own power. Very little of the usable parts of a tree are now wasted, as portable chippers are taken into the forest to make chips of all but the smallest branches. In the Maritimes, wood chips are even being used for space heating in industry and large institutions such as schools and hospitals.

The aesthetic and environmental effects of deforestation are devastating and can lead to soil erosion and loss of natural beauty. Reforestation efforts are under way, but the pace does not keep up with the rate of deforestation.

> *"Lack of adequate forest management in the past has resulted in depletion of the forest resource. Significant shortages of wood are now reported at the local level in every province."*
>
> *- Federal Auditor General Kenneth Dye*

Recycling of paper products is practical, economical and allows us more use from trees. For example, 17 trees will produce one tonne of newspaper, (a stack 17 metres high), or enough cellulose fibre to completely insulate an average-sized home. Recycling of paper was practised during World War II when most northern countries, including Canada, recovered half of all paper consumed through recycling to aid the war effort. Paper recycling is becoming more popular, and recycling centres are now located in many communities.

IV. WATER

Water, necessary for human existence, can also be used as an energy source. Its use ranges from the impressive scale of grand hydro dams, to small units in flowing rivers or even streams. The use of water for energy generation dates from 1 000 B.C. in China, Egypt and other areas in the Near East. The first type of commonly-used device in the 19th century was the water wheel, followed by the development of turbines to extract larger amounts of energy.

To generate a large amount of electricity, damming is required. One of the considerations of selecting a suitable site for hydroelectric generation is reliable water flow rate. If it is variable, damming may be necessary. Environmental impacts must also be considered. Damming can disrupt the delicate balance needed for fish and animals, agricultural land will be lost to flooding, and communities may have to be relocated. While there may be public opposition at the loss of a river, the addition of a man-made lake or reservoir may be welcomed.

For smaller amounts of power, low head hydro can be used. It converts the natural currents in rivers and lakes ("falling" water) into mechanical energy and then electricity. It can be used in small-scale applications to provide electric power to remote locations such as logging camps, ranches, and homesteads, or on a larger scale to provide power for entire communities.

Hydroelectric generation is now regaining some of its former popularity, which had declined with the availability of cheap electricity generated by fossil fuels. Although the fuel costs are low for this type of electricity generation, operating and maintenance funds are required, and capital costs are high. Hydroelectric power is being used or planned in every province in Canada except Prince Edward Island, although Alberta's use is low due to limited potential in our province.

Although many people think that water is free and so think nothing of wasting it, in Alberta we do pay for it. For example, the average family pays 53.6 cents for the heat, water and sewage required for every load of laundry, not including the cost of drying. In a week, this could add up to

$5.36. A tap dripping once per second in one month would fill 20 bathtubs - or 9 L per day. The average Alberta school pays approximately $1,785 per year for drinking or heated water and sewage treatment.

Water power is also available from the ocean through wave power, tidal power, and ocean thermal energy conversion. Wave power is difficult to capture because although the water appears to move laterally, its motion is actually more orbital. Until now wave power has been mainly used on a small scale only, although with research perhaps this abundant (although intermittent) power can be used it on a larger scale.

The gravitational pull of the moon on the earth sets up a single wave system that circles the globe, the resulting rise and fall of the oceans observed at their shores are **tides.** Turbines can use this tidal motion both as it rises and falls, converting kinetic energy to electrical energy. This massive potential of energy generation has been harnessed at the successful tidal-power plant in the Bay of Fundy. Seawater is admitted into a dammed holding pond while the tide is coming in, then trapped and forced to flow out through a turbine, generating electricity as the tide ebbs.

Ocean Thermal Energy Conversion is an experimental power generation system which takes advantage of the temperature difference between the upper layer of the ocean (about the first 100 m), to depths of about 1 000 m. The most important location for this type of application is at the equator where deep sea water may be from 15 °C to 25 °C colder than the surface water.

V. GEOTHERMAL ENERGY

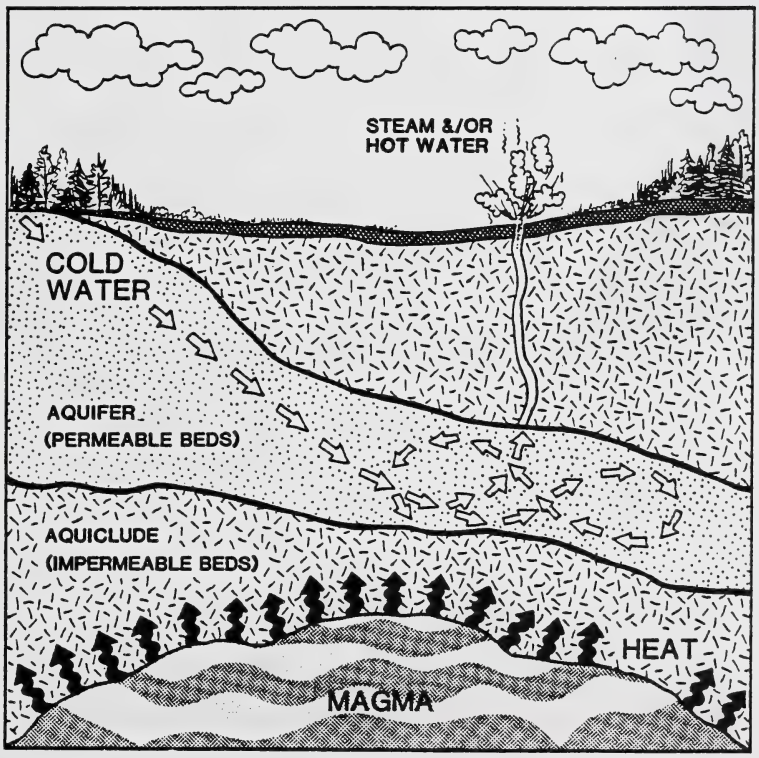
According to the theory of global plate tectonics, the earth's crust consists of a layer of several dozen plates which float like rafts. Heat-driven currents in the flexible interior of the earth move these plates, causing the intense volcanic activity, earthquakes and geysers and hotsprings characterized by these areas of the earth where plates come in contact. The water heated from deep within the earth emerges above ground in the form of streams, pools, or shooting jets.

The groundwater or gas which is heated by geothermal energy becomes hydrothermal energy. It can be used to produce clean, cost efficient renewable energy, in different applications depending upon location, ease of retrieval, and temperature. Even "low-temperature" sources of 50 °C to 100 °C can be used by fish hatcheries and greenhouses, and to provide building heat.

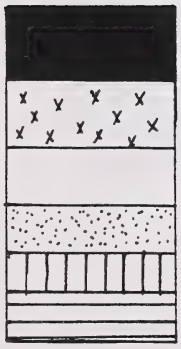
Geothermal energy is in use in about 130 locations in the world, including the U.S.A., Japan, Norway, Sweden and New Zealand. In Iceland, much of which is underlain by hot springs, geothermal energy has been used quite extensively for heating buildings and fresh water, and for driving turbines. Once dependent on imported fruit and vegetables because of their remote location and harsh climate, Iceland is now are able to grow their own, all year-round, in vast greenhouse complexes which are heated by geothermal energy. In Alberta, considerable geothermal potential exists in the Edson/Hinton area, and at such hotsprings as Sulphur Mountain in Banff National Park.

VI. HYDROGEN FUEL

Research in progress is attempting to develop technology for using hydrogen, a common and clean element, as a fuel. This fuel burns very cleanly, but is still impractical for wide-scale use because it is so light it cannot be contained by a common gas tank, and requires very specialized containers for storage. It could replace carbon-containing fuels such as gasoline and diesel oil. Currently, Quebec and the European Community are working together to develop such technology, which could help reduce the amount of carbon dioxide in the atmosphere considerably.



ORIGIN OF GEOTHERMAL ENERGY
FIGURE 18



Cordillera: Mountains, includes the Coast Range. Its young active volcanoes border the Pacific. Excellent potential for geothermal power.

Western Canadian Basin: Sedimentary basin of sandstone and carbonate extends from Manitoba to B.C. It is estimated that the energy content of all the water at temperatures above 50 °C in this area exceeds that of 8 million barrels of oil.

The Canadian Shield: This immense shield-shaped tract of ancient rock is of no geothermal interest.

Sverdrup Basin: Western Arctic. Sedimentary rocks carry water warm enough to heat buildings.

St Lawrence Lowlands: Shallow basins, water not warm enough for geothermal heating.

Atlantic Region: Contains granites with abnormally high concentrations of radioactive elements. Could be of use as further technology develops.

CANADA'S GEOTHERMAL POTENTIAL
FIGURE 19

VII. ENERGY CONSERVATION

While energy conservation or efficiency is not an energy source as we consider others to be, increasing energy efficiency could save so much energy that it would be equivalent to discovering a completely new source of energy! Because of increasing efficiency, but despite a growing population and economy, Canada consumes little more oil now than we did in 1970.

Some of the new technologies and products which increase efficiency include highly-insulative windows, air-to-air heat exchangers, industrial heat recovery equipment, energy monitoring and control equipment, computerized building energy management systems, energy-efficient mass transit systems, efficient lighting systems, heat pumps and high efficiency heating systems.

In a study by the Environment Council of Alberta, it was estimated that throughout the commercial sector, (including retail and wholesale, apartment and office buildings), energy savings of 50 to 55 percent are possible through increased energy efficiency. Fuel savings of 25 to 70 percent are possible from the institutional sector (schools, hospitals, universities and government agencies). The industrial sector has already reduced its energy consumption by 12 percent over the last decade, and the transportation and agriculture sectors have also improved. In dollar savings, these savings total over $600 million. If all these potential energy savings were added together, we could ...

... save more natural gas than is used to heat all single-family homes in Alberta for a full year;

... save almost as much electricity as one new Genesee generating unit can produce in a year;

... save more diesel fuel and gasoline than all the cars in Edmonton would use in a full year.

Energy conservation also helps us to accomplish sustainable development in the following ways:

- Oil and gas will last longer, and ensure our province's prosperity longer.

- Reducing our energy demand will make our economy more stable in the long run. We will be less affected by fluctuations in conventional energy supplies and prices. We will also have more options for meeting our future energy needs.

- Energy conservation can diversify and expand our local economy. If we spend less money on energy, we have more money to invest in Alberta business and industry. Each individual energy user in Alberta will have more money to spend in new ways. Energy conservation also frees capital. A recent study estimates that the United States could avoid building 20 1,000-megawatt power plants by using existing technology to improve fluorescent lights. The cost of an additional 30 power plants could be saved by meeting new appliance standards for refrigerators and freezers.

- Conserving energy is a less risky investment than some forms of new energy supplies. There is rarely a need for long lead times to plan and implement conservation initiatives, which, combined with quick payouts, make them attractive to enlightened energy users. Conservation is often viewed as a cost-effective equivalent to new energy production.

CHAPTER 3

THE ENERGY/ENVIRONMENT CONNECTION

"Most persons think that a state in order to be happy ought to be large, but even if they are right, they have no idea of what is a large and what a small state ... To the size of states there is a limit, as there is to other things, plants, animals, implements: for none of these retain their natural power when they are too large or too small, but they either wholly lose their nature, or are spoiled."

Aristotle, 322 B.C.

The Earth's population is larger than it has ever been, and we are more technologically advanced than ever before. When does this growth stop? Does it continue for its own sake? Our society today has evolved around the principle of controlling the planet's resources, challenging natural and environmental limits rather than living within them. This role of "Man as Manipulator" has brought us amazing advances in science and technology that have allowed mankind to escape disease, overpopulation, pollution, etc. But no one knows just how much the earth can take - have we surpassed any of the limits already? Science and technology have saved us in the past, but can we rely on it every time, like a fail-safe mechanism?

The solution to our current crisis may not lie in technology. This time, we may need a massive human effort to cure the damage caused by humans. And it is not important that we agree on the language, or all the causes and effects. Much of the evidence is plain and cannot be disputed - energy supplies are dwindling, our resource consumption is polluting the biosphere, as the population grows exponentially there will not be enough food for them, because there will be less arable land, and the remaining land will be less productive.

Newton's Third law states that every action has an equal and opposite reaction, but for the last 100 years society has operated as though this law were not a reality. The economy has grown, the population has skyrocketed, use of resources has escalated astronomically and now the environment is in jeopardy.

People started talking about the environmental crisis as early as 1969. U Thant, the former Secretary General of the United Nations, said that there was less than a decade to reverse the damage which had been done to the earth. Barbara Ward, a noted British scientist, likened our situation to a journey on Spaceship Earth, with limited resources requiring careful management. The Club of Rome undertook a study on the Predicament of Mankind, and developed sophisticated computer models to predict the future of our species and the earth. More recently, the World Commission on Environment and Development was formed by the United Nations and headed up by Prime Minister Gro Harlem Brundtland of Norway, to plan a world conservation strategy. They contend that we can no longer ignore the earth's limits, that we must live within them and realize that something must be done if mankind is to survive. Although the warnings seem stern, the evidence is staggering.

A. WHAT HAPPENED?

The damage that has been done to the earth has occurred in what seems like the blink of eye, in terms of the whole of human history - in only the past 100 years. Many of the causes of the earth's deterioration are related to energy use, including inefficient and damaging large-scale harvesting of resources, pollution from energy consumption, the processing of products from energy sources and the effects of their use.

Many social issues have contributed to environmental damage - many people no longer feel any connection with or responsibility to the environment. Greed has become a human virtue, to the extent that money is more important than positive human values. Economic developments are more important than the environment. Most developing nations are insecure economically and politically and survive only through drug trafficking, and most nations increase military power before ensuring basic needs for their people. Perhaps most of all, cynicism has spread to young people, most of whom have no hope for the future of the world, and no feeling of empowerment.

A prevailing attitude has been that "somebody should do something about this". But who, if not the citizens of the world? We should all feel a stake in healing our planet, as it is the reason we all have life. We need to take action ourselves, there is no global body whom we can count on to save our world.

The boundaries on our planet (that is, those which are not geographical) are man-made, created for political reasons. However, most of our problems transcend these boundaries. Searching back in history will not give us the solution, because the conditions which exist today are unprecedented. We have experienced many changes in a microcosm of time, but this doesn't seem to be one of those things which will right itself.

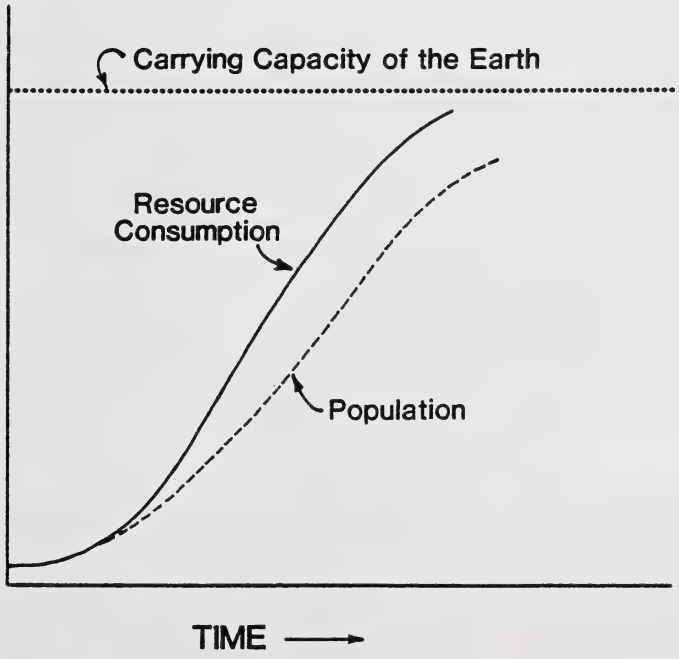
1. Resource Use

Throughout most of history, wood has been the major energy source, with some limited use of other renewable resources. Coal was introduced in the Industrial Revolution and was used extensively until this century, when oil and natural gas became the principal world energy resources. Many people hold the misconception that these fossil fuels are in abundant supply, but this is not the case. What it has taken millions of years to make, we have almost completely consumed in one century.

In the third world, the main energy source is still wood, with some oil required for transportation and sometimes providing some electricity. To buy this needed oil at ever-increasing prices, their search for a tradable commodity with which they can get cash to purchase oil, leads them to harvest much more of their forests than before, with several consequences. For example, the cost rises as the supply dwindles, and as rural people have little purchasing power they cannot afford to buy it for cooking and heating, and they are forced to burn dung which would normally have gone back into the soil as fertilizer. Because the farmers cannot afford petroleum-based fertilizer, the soil goes unfertilized and deteriorates in quality. Soil quality also deteriorates through erosion which causes pollution downstream due to silt build-up and increased acidity. Another consequence of the deforestation caused by the demand for oil is global warming, because there are not enough trees to absorb the increased concentration of carbon dioxide in our atmosphere, contributing to the greenhouse effect.

All countries in the world have at one time or another made serious mistakes in planning. Economic development has not considered the human or environmental impact. All over the world, we see resources growing more scarce. That is why the trend is towards sustainable development - the crisis is starting to hit home with everyone. As stated by the Federal Energy Minister Marcel Masse at the 1988 Pollution Probe Conference in Toronto,

> *" ... in the search for a sustainable energy policy, a number of preferred options emerge. The first must be conservation ... The next (must be) intensified work on renewable forms of energy."*



CARRYING CAPACITY OF THE EARTH
FIGURE 20

2. The Greenhouse Effect

The term "greenhouse effect" is most commonly being used in a negative way, but without it, life on earth would not exist. It is similar to what happens when a closed-up car is left in the hot sun - it becomes much hotter than the outside air. The sun's ray pass through the atmosphere and are absorbed by the earth's surface, heating it up. Some of this heat radiates back into space, but some of it is captured in the atmosphere by a layer of greenhouse gases, keeping the earth's surface and the air surrounding it, warm enough to support human and plant life. If this blanket-like layer of greenhouse gases were not there, the surface of the earth would be cold and barren.

Scientists believe that the earth's atmosphere is heating up more than it would under normal conditions. The balance of greenhouse gases is trapping some of the heat which would otherwise be radiated into space. This heat artificially warms the atmosphere. Although currently under debate, some experts say that the global warming trend and Alberta's more erratic and less severe climate are likely caused by the greenhouse effect.

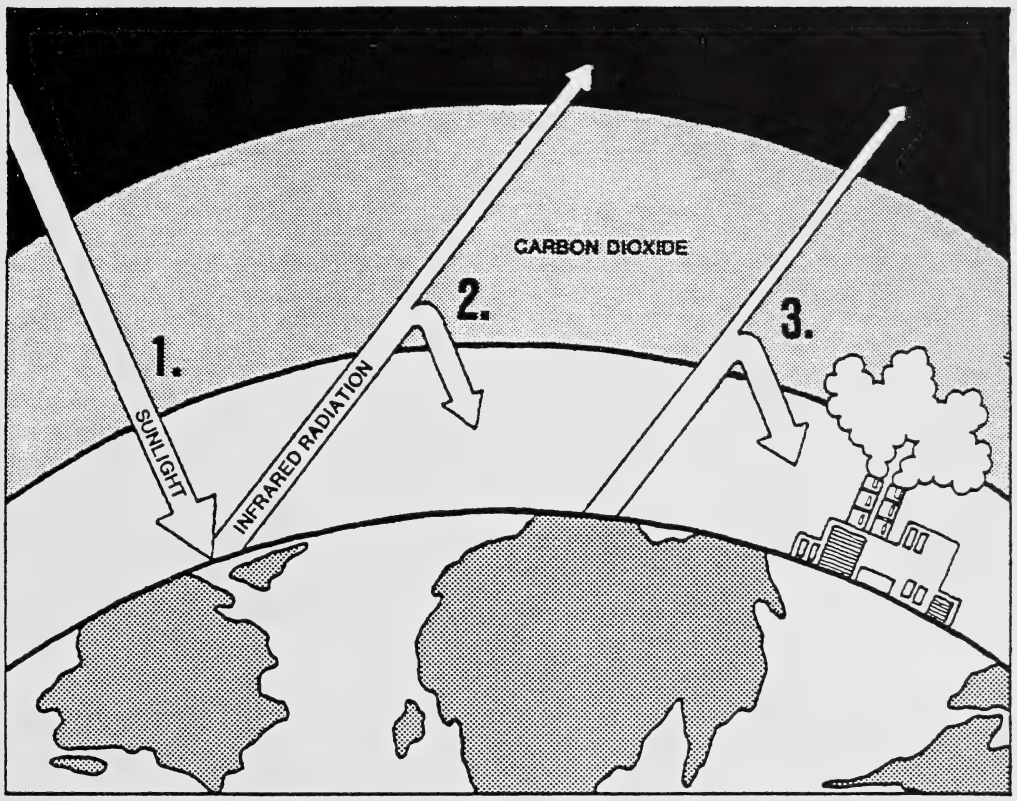
The possible impact of man on the greenhouse effect was first recognized in the early 1800s. By the turn of the century, calculations were being made relating increases in atmospheric CO_2 to temperature change. At that time it was estimated that doubling or tripling the amount of CO_2 in the atmosphere would lead to a temperature increase of up to 9 degrees Celsius. Since that time, however, carbon dioxide levels have increased by 26%, and global temperatures have increased approximately 0.5 degrees Celsius.

The greenhouse effect is caused by the emission of man-made greenhouse gases from processes such as the burning of fossil fuels. These gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ground-level ozone (O_3). Most of these emissions come from automobile exhaust and fossil fuel combustion at power plants, in industry and from homes. Chlorofluorocarbons (CFCs) also contribute to the greenhouse effect, and are given off by refrigerators, fire extinguishers, air conditioners and heat pumps, some aerosols, and the production of some plastic foam products. Another greenhouse gas is methane, produced through the decomposition of organic matter, in rice paddies, and by ruminants, such as cattle, sheep, and termites, through digestive rumination.

Canada contributes 480 million tonnes, or 2% of the world's annual man-made carbon dioxide. Although this is a smaller portion of the larger global problem, Canada's per capita contribution is relatively high, mainly due to our industrial base and our energy-intensive lifestyle. Due to its large fossil fuel industry, Alberta is the leading per capita producer of CO_2 in Canada, and second, in absolute volume, to Ontario.

There is uncertainty as to what long-term effects we will see as a result of the changing balance of gases in the atmosphere, and the increase of man-made greenhouse gases. Some scientists use complex computer models to simulate what might happen if, for instance, CO_2 concentrations in the atmosphere double (at the current rate of increase this could happen in 50 or 60 years). While there is not agreement on the amount and location of climate change, it is estimated the average global surface temperature could increase 1 to 5 degrees Celsius, and that there could be substantial change in precipitation patterns. This amount of global warming would in normal circumstances require between 10 000 to 20 000 years to evolve - a significant time period, which allows for adaptation. It is believed northern latitudes (including Canada) would be affected more than equatorial regions; however, the effects of higher temperatures, accompanied by rising sea levels and changes in precipitation would be global. Food production could be affected by both coastal flooding and more frequent and severe droughts. Fresh water supplies, forest and land use could also be affected. In low-lying coastal areas, rising sea levels caused by melting glaciers and polar ice, and the warming of the oceans, could require major diking projects to prevent flooding ore location of population.

THE GREENHOUSE EFFECT



1. SUNLIGHT STRIKES THE EARTH, WHICH RADIATES HEAT AS INFRARED RAYS

2. CARBON DIOXIDE (CO_2) IN THE ATMOSPHERE TRAPS SOME OF THE HEAT, MAINTAINING THE EARTH'S TEMPERATURE

3. INCREASED LEVELS OF CO_2 AND OTHER GASES FROM MAN-MADE SOURCES SUCH AS FOSSIL-FUEL EMISSIONS TRAP MORE HEAT, RAISING THE TEMPERATURE

THE GREENHOUSE EFFECT
FIGURE 21

Despite the uncertainties and continued debate, there is general agreement that actions should be taken now to reduce man-made greenhouse emissions, particularly if reduction measures also have positive social and economic benefits, such as improved energy efficiency. However, immediate action will not produce immediate results but will have effect in the long term only. Even if we reduce our emissions of greenhouse gases today, the impact will not be apparent for many years.

3. Acid Deposition

Acid deposition is a broader term than the more common acid rain, but they are often used interchangeably. Throughout the world, the processing and burning of fossil fuels produces sulphur and nitrogen oxides. In the atmosphere, these emissions are converted chemically to sulphuric acid and nitric acid, among other products. These acids, and other substances, can fall to earth in rain, snow, sleet, hail, or fog, and enter the water cycle. When it is not raining, these oxides interact directly with the soil, vegetation and water in a variety of ways referred to as dry deposition.

In Alberta, the major sources of sulphur oxides are natural gas processing, oil sands plants and coal-fired power plants. These are primary industries and integral to the province's economic structure. The major sources of nitrogen oxides are automobile exhaust, and industrial activities ranging from the operations of the petroleum industry to electric utilities, to fertilizer, cement, chemical and pulp and paper industries. Although vehicles must meet ever stricter exhaust emission standards, it is a growing problem considering the concentration of automobiles in our society and increasing jet travel.

Our Alberta coal, used to generate electricity, is low in sulphur content and therefore does not contribute appreciably to acid precipitation, but it does contribute significantly to the greenhouse effect. Global warming may increase the amount of acid deposited, because warmer temperatures stimulate many of the acid-forming processes. Coal from the northeastern United States has a higher sulphur content, and is used widely in Ontario industries. The mining and industrial use of this coal is responsible for significant acid rain damage in the Great Lakes region; however, they cannot economically use our "cleaner" coal in Ontario because of high transportation costs. Cleaner combustion methods are being developed - but if U.S. coal were abandoned in favour of Canadian coal, the economy of areas dependent on mining industry can suffer greatly.

Acid deposition will damage the ecosystem when the following three factors are present:

- emissions must be sizable and over a large area
- there must be sensitive eco-systems downwind of the source
- weather patterns must be such that they transport pollutants to the sensitive area allowing enough time (and distance) for the chemical transformations to occur.

Alberta is less susceptible to acid deposition damage than is Eastern Canada, due to our area's generally alkaline soils and bedrock, and alkaline dust which helps to neutralize acidity.

When these conditions occur, acid rain can have many serious effects, which have been documented around the world, since as early as 1872. Acid deposition reduces the productive capacity of lakes and soils. Over time, it will make some soils and bodies of water too acidic for the indigenous life forms, and affect everything that drinks or lives in these waters. The acidic lake water kills the eggs and the young of fish, and leaches calcium out of the bones of adult fish, deforming their spines. As the fish disappear, the birds and mammals which depend on them for food also disappear, and the ecosystem deteriorates. Lakes are being damaged at an increasing rate - it is estimated that in eastern Canada, 14 000 lakes have sustained significant damage, and another 150 000 are threatened, out of our estimated two million lakes. Many of these lakes may never support life again.

Acid rain causes metals to leach out of the soil and accumulate in water and in the food chain. Agricultural crops can be damaged directly or by reduced soil fertility. Forest growth can be retarded and leaves and needles damaged. The legendary forests of Europe are being destroyed by acid rain, and already several mountain villages in Switzerland have been decimated by avalanches which would have been prevented had the forest cover been more dense or healthier.

Our forests are also in peril. Acid rain causes spotting and burning of leaves and retarded growth. They become more subject to damage from the cold of winter and from insects. Canada's famous maple syrup industry is in danger, as 83 per cent of the maples show damage from acid rain, and many of the trees are dying. The industry has already lost two million of its 14 million taps.

The acidic particles transported in weather systems not only reduce visibility, they can impair lung functions and affect breathing. Acid rain corrodes car bodies and eats away the surfaces of buildings and monuments.

Programs involving government and industry in Canada and Alberta are studying the causes and effects of acid deposition, and nations are co-operating to establish clean-air treaties, recognizing that acid rain, and many other environmental problems, cross international borders.

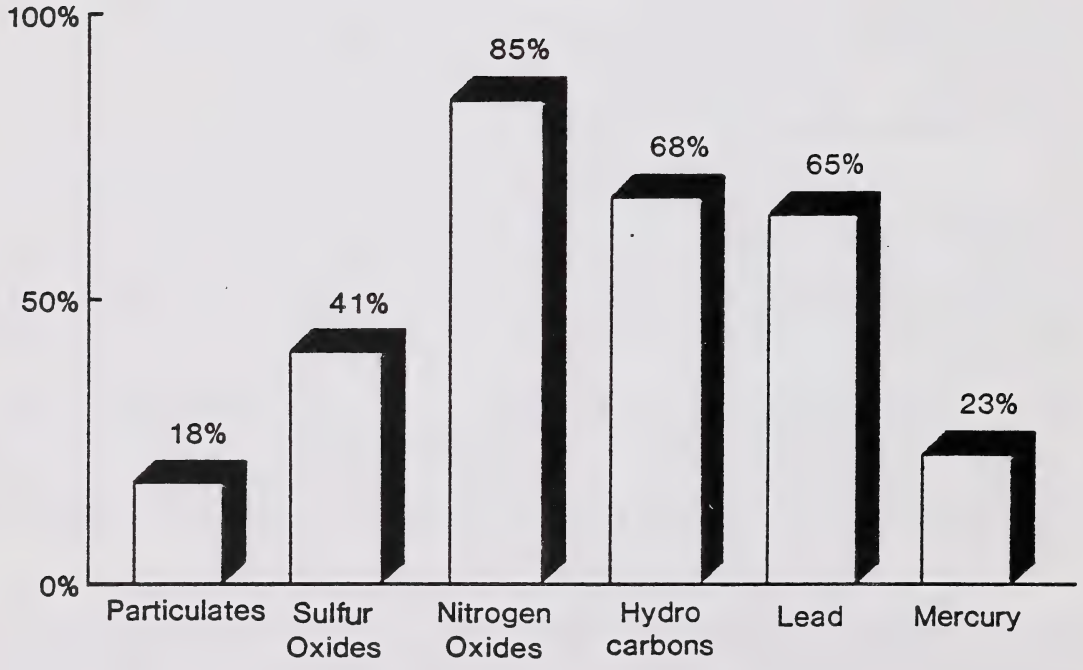
4. Ozone and Smog

In the stratosphere, the ozone layer acts as a natural filter absorbing most of the sun's damaging ultraviolet rays - those that burn skin and cause some forms of skin cancer. Most of the ozone (O_3) in the earth's upper atmosphere is in a 20 km thick layer at a height of 15 km to 35 km above the earth's surface. It forms a protective blanket which prevents ultraviolet radiation from reaching the earth's surface. Ozone, which is poisonous at ground level in high concentrations, is formed by the O_2 atom splitting apart to form single O atoms, which then join up with other O_2 atoms to form ozone, O_3.

Scientists have reported a thinning of the ozone layer. In some cases such as in the Antarctic, holes have appeared. As the shield of ozone thins, more ultraviolet rays will penetrate, causing a variety of concerns. Higher levels of ultraviolet radiation can lead to an increase in sunburn, eye damage and skin cancer. Increased ultraviolet radiation can also cause serious damage to the aquatic food chain and affect the productivity of some grain crops, which would then impact on the energy and food supplies available to an ever-increasing population.

The ozone layer is being depleted by such substances as chlorofluorocarbons (CFCs), methane, and nitrous oxides (NO_2). CFCs are used widely as a coolant in refrigerators and air conditioners, in CFC-blown foam as in foam insulation, cushions, plastic foam containers such as those used in the fast-food industry, and urethane soles for shoes. CFCs can also be used as a propellant in some aerosols, and for sterilizing surgical instruments, freezing seafood, and cleaning printed circuit boards in computers, compact disc players, video recorders, and televisions. When these CFCs are released into the atmosphere, they travel up, are not absorbed in the atmosphere, and break through into the ozone layer where they prevent ozone from being formed. The ultraviolet radiation breaks apart the normally stable CFCs, releasing chlorine which acts as a catalyst in the destruction of ozone. Halons, similar to CFCs, are up to ten times more potent as ozone depleters but are used widely as excellent fire extinguishers.

Methane is produced in rice paddies, landfills, and by ruminants, such as cattle, in their digestive process. Nitrous oxides are produced by the energy industry and from the combustion of gasoline in automobiles.



CONTAMINANTS FROM
ENERGY PRODUCTION & CONSUMPTION
(as percentage of total pollution)

CONTAMINANTS FROM ENERGY PRODUCTION
FIGURE 22

There is also concern with ground-level ozone because at that level it is a serious pollutant. In the 1940s, increased concentrations of ground-level ozone were seen in Los Angeles. Ozone is a major component of photochemical smog, which has a noticeable light brown colour and results in reduced visibility. Ground-level ozone is formed when volatile organic compounds, or VOCs, react with nitrogen oxides in the presence of sunlight. Motor vehicles, solvents and industrial processes in the petrochemical industry are sources of VOCs, while the burning of fossil fuels is a major man-made cause of NO_x.

The "Montreal Accord" signed in September of 1987 was a treaty signed by 24 countries, including Canada, reducing CFC production by the world's industrialized nations to 1986 levels within three years, to be further halved by 1999. In early 1989, Canada's Environment Minister announced a plan to reduce CFC use by at least 85% by 1999. Many major CFC producers have stepped up research efforts and developed alternatives which are coming into use, largely due to consumer demand for more environmentally-friendly products. These new chemicals are designed to break down more quickly than CFCs, not to reach the stratosphere in the same quantity, or do not contain chlorine.

5. Population Growth

The world population grew from one billion to two billion over a period of more than one hundred years. The increase to three billion was added in 30 years, and then jumped to four billion in less than 20 years. If this pattern is followed, the earth could see up to seven billion people before the year 2000, and by 2050 the population would be double that of 1987!

To support this population, an adequate food supply is required. As mentioned earlier, our food production capacity is decreasing yearly through deforestation, soil erosion, desertification and acidification. In addition, our seas are being damaged by oil spills and depleted by overfishing. The world's catch has already been reduced to about 75 to 80 per cent of what it could be.

6. Soil Erosion

Worldwide, soil erosion has become a cause for concern. Every year in North America, winds blow away tonnes of topsoil from fields left unprotected due in part to ineffective farming practices, and in developing nations, deforestation exposes the soil to erosion.

In the Third World, the increased acidity of the soil, drought and loss of topsoil has led to encroachment of the deserts and farmland which cannot support even its tenders. Deserts now expand almost 60 000 square kilometres a year (an area about the size of Nova Scotia). Due to these and other practices, the forest cover of the earth has decreased dramatically, allowing valuable soil to be washed away by streams and rain and blown away by wind. Not only does this jeopardize the livelihood of millions of people, it is also a factor in the greenhouse effect, because there are not enough trees left to absorb the ever increasing amount of oxides being pumped into the atmosphere.

The U.S. Department of Agriculture figures that one hectare of U.S. farm land now feeds one human being somewhere in the world. Already the U.S. has lost so much soil that its potential to grow food has been cut by at least 10 to 15 per cent. Every hectare lost is another person who goes hungry - and for every increase of 1000 in Canada's urban population, 320 hectares of arable land are lost by the world's main grain suppliers.

7. Nuclear Energy Use

The safety and use of nuclear energy continues to be debated hotly. A great advantage of nuclear power generation is that it produces massive amounts of energy at a low cost, and does not emit CO_2 as does power generated by fossil fuels. Just as oil and natural gas became the major energy source of the 20th century, nuclear energy could have the potential to take over this role in the next century. In many countries, including some areas of Canada, nuclear energy is used widely to generate electricity. The CANDU reactor is considered worldwide to be superior technology, however, to some, nuclear energy is never safe enough.

Actually, nuclear energy has very few environmental effects, but the few effects it poses are extreme. Safe disposal methods of nuclear wastes do not exist. With some of these wastes remaining active for hundreds of years, the politicians and corporate executives who dictate current policy will not be alive later to ensure that safe disposal or storage are practised.

Nuclear power plants are equipped with state-of-the-art fail-safe security systems, however, the danger of nuclear reactor accidents cannot be discounted. Incidents of nuclear accidents and their effects such as at Chernobyl and Three Mile Island are hard to forget.

In the event of nuclear war, some fear that terrorism would escalate to uranium thefts from power plants for making nuclear arms. This terrorism would endanger the health and safety of the occupants of the area, not only from attack but from possible reactor accidents if the safety and integrity of the nuclear facility were violated.

Because nuclear power plants generate vast amounts of electricity, they are centralized and cause significant problems if the power supply is interrupted. If an accident or attack were to occur, not only would nuclear fallout cover the area, but a vast area would be left without power, thus being effectively demobilized. Until renewable energy sources are given a fair trial, and as long as large-scale technology is viewed as the answer to all energy supply problems, nuclear energy is here to stay.

8. The Garbage Crisis

In most nations of the world, the disposal of garbage has become a monumental problem, with our disposables overflowing landfill sites. Canadians produce the most waste per capita per day at 1.7 kg, compared to 1.6 kg per person in the United States, 0.9 kg in the United Kingdom, and only 0.5 kg per person in China. In one year, the average Canadian discards 620 kg of garbage, including 193 kg of paper; Canadians collectively throw out 24 million tires, 175 million spray cans, 300 million litres of motor oil, and 250 000 tonnes of disposable diapers. All of this trash goes to landfills, wasting all the energy that it took to make these things, mostly non-renewable energy sources, gone after one use. Likewise, the 4 trees it took to make the 193 kg of paper thrown out by every man, woman and child, are gone. Reforestation does not keep up with the deforestation, and most pulp mills pump many pollutants, including dioxin which causes birth defects in animals, into our rivers and groundwater. The disposal of toxic wastes in landfill sites pollutes our groundwater locally, and internationally, hazardous wastes are shipped to unwitting third-world countries for disposal - often in villages or on poor worker's farms. Major Canadian cities are running out of landfill sites, as citizens fight back saying that they don't want them - "Not in my backyard!". The cities are now trucking garbage away to rural sites, raising the cost of garbage disposal.

Recycling efforts are increasing. For example, in Edmonton, the Blue Box home recycling program is one of the most successful anywhere. Homeowners are supplied with plastic boxes into which they place recyclable materials of newspapers, cans, and glass containers. It is planned to expand this program to include apartment buildings and institutions. Many organizations are now

getting involved in recycling, and paper recycling services and bottle depots are becoming more common. The one tonne of paper discarded by each Canadian family every year, a pile of newspapers 17 m high, can be recycled into enough cellulose fibre insulation to insulate the average home. Paper can also be recycled into flower pots, shingles, and more paper products. A can made out of recycled aluminum uses 95% less energy than making a can from new metal, which is equivalent to the energy consumed by burning a 100 watt light bulb burning for 4 hours. Clear glass can be recycled indefinitely without losing quality, and some of the products it can be recycled into include reflective paint for highway markings, glass containers and insulation. Metal can be recycled into rebar, new beverage containers and automotive parts.

B. A NEW WAY TO LOOK AT THE WORLD

"We travel together, passengers on a little spaceship, dependent on its vulnerable reserves of air and soil; all committed for our safety to its security and peace; preserved from annihilation only by the care, the work, and I will say, the love we give our fragile craft."

- Adlai Stevenson

Our world systems are interdependent. For example, the population grows because there is enough food to support its increase, but food production for a growing population can only be increased with more capital. Increased capital requires more resource consumption, but increased resource consumption and its discarded waste become pollution. Pollution interferes with the growth of both the population and food production. The world is now reaching a crisis stage, where we now must make decisions - how to use and manage the earth's resources in a manner which permits sustainable development and ensures a quality environment, without jeopardizing economic stability.

1. A New Philosophy

Although not new to some people, it is time to start treating the world like a living, integrated ecosystem. The earth did not start out with political boundaries, and even geographical boundaries have meaning only for the humans who observe them. We have borrowed the earth from our children and have the responsibility to return it to them in a condition which will ensure their existence. In short, we should treat it as though we intend to stay.

Harmony with nature has been valued by other cultures including American Indians and Eastern cultures. Western practice and belief reflects a different philosophy, that man has the right to dominate and control the earth. An increased respect for the earth's resources, and an appreciation for nature, would ensure balanced use of energy. As stated by Native American Chief Seattle in an address to the president of the United States in 1855,

"Humankind has not woven the web of life. We are but one thread within it. Whatever we do to the web we do to ourselves. All things are bound together. All things connect. Whatever befalls the Earth befalls the children of the earth."

2. Who is Doing Something About it?

A World Conservation Strategy was developed by the International Union for Conservation of Nature and Natural Resources, the United Nations Environment Program, and the World Wildlife Fund. Its purpose is to stimulate a more focused approach to the management of living resources and

also to provide policy guidance on how this can be done. It is intended to be carried out by governments, conservationists and development practitioners. The three main objectives of the World Conservation Strategy are:

a) to maintain essential ecological processes and life-support systems,
b) to preserve genetic diversity, and
c) to ensure the sustainable utilization of species and ecosystems.

The implementation of this strategy is urgent because the planet's capacity to support human life is being irreversibly reduced, hundreds of millions of rural people in developing countries are compelled to destroy the resources necessary to free them from starvation and poverty; the energy, financial and other costs of providing goods and services are growing; and the resource base of major industries is shrinking.

The objectives of the World Conservation Strategy can only be attained if some obstacles can be overcome. For example, industry and government have traditionally viewed conservation as a limited sector; conservation plans are not integrated with development plans; development processes and energy use are often inflexible and needlessly destructive to the environment; short term interests are more commonly favoured than longer term ones; conservation is not legislated or enforced; lack of trained personnel; lack of basic information on priorities and the productive and regenerative capacities of living resources; and the failure to deliver conservation-based development where it is most needed.

The World Conservation Strategy has proposed that every country formulate their own strategy to make global environmental issues a priority and responsibility of their government. In Canada, this has been created by Environment Canada, supported by Energy, Mines and Resources Canada. In Alberta the Environment Council of Alberta has created its own document to be implemented in Alberta - the Alberta Conservation Strategy.

The six objectives of the Alberta Conservation Strategy are:

1) maintaining essential ecological processes,
2) preserving genetic diversity,
3) sustaining use of species and ecosystems,
4) developing diverse opportunities for use of natural resources,
5) maintaining and improving quality of urban life, and
6) developing a long-term, sustainable economy.

Detailed information as to the particulars of this strategy can be obtained from the Environment Council of Alberta - see the Supplementary Resource list.

3. What is Happening in Canada?

Canada is the most energy-intensive industrialized country in the world, in part due to our harsh climate, vast distances and low population density. However, we have come a long way since the "energy crisis" of the early 1970s. Between 1973 and 1986, energy use per unit of production dropped 14 per cent, from consumers responding to energy price increases, improvements in technology and government programs to accelerate conservation measures and oil substitution. Although this does sound impressive, the United States and Japan have reduced energy consumption even more than we have.

Conservation is starting to become more common. For example, new homes use 25 per cent less energy than homes built in 1974. More energy efficient homes are being built which use only 30

to 40 per cent of the energy consumed by a home built in 1974. In the transportation sector, pressure has been put to bear on domestic automobile manufacturers to compete with the more energy efficient imports, which consumers have chosen in increasing numbers. The four Rs of recycling, reducing, reusing, recycling and reducing, and using environmentally-friendly consumer products, is becoming part of our everyday lives.

4. What are the Alternatives?

As mentioned above, the World Conservation Strategy is aiming for a sustainable energy future. For Canada and Alberta, this could include actions such as retaining emergency oil supplies and spare productive capacity; enhancing multi-fuel capacity to provide the ability to switch from oil to alternate sources in emergency times; reducing the amount of oil exported and increasing the use of renewable energy sources. Preventively, we can begin to change energy consumption by reducing our reliance on oil which we import to some regions of Canada to where it is impractical to transport our oil, and diversifying our sources of imports.

5. What Can I Do?

Solutions can begin in schools, neighbourhoods and homes. Individuals need not speak alone, they can join with other interested individuals and increase their power. Choose any of the activities included in the Activity section, or join a special interest group.

Take action! Start with yourself, and by your example and words, educate others and encourage them to take their part to get involved. Encourage your students to get involved, too. The Supplementary Resources section lists Special Interest Groups for teachers and students, groups which are involved in energy and environment issues. Contact any you are interested in.

Above all, take responsibility yourself for the condition of your environment and, by positive example and encouragement, get others to do the same. Every voice, every action helps.

The Weight of Nothing

"Tell me the weight of a snowflake," a coal-mouse asked a wild dove.

"Nothing more than nothing," was the answer.

"In that case I must tell you a marvellous story," the coal-mouse said. "I sat on the branch of a fir, close to its trunk, when it began to snow, not heavily, not in a raging blizzard, no, just like in a dream, without any violence. Since I didn't have anything better to do, I counted the snowflakes settling on the twigs and needles of my branch. Their number was exactly 3 741 852. When the next snowflake dropped onto the branch - nothing more than nothing, as you say - the branch broke off."

Having said that, the coal-mouse flew away.

The dove, since Noah's time an authority on the matter, thought about the story for a while and finally said to herself; "Perhaps there is only one person's voice lacking for peace to come about in the world."

- Source Unknown

Change in energy use patterns is not enough to answer all of the earth's environmental problems. Not only must this issue must be addressed on a global scale, but individual commitment and involvement are also necessary. Worldwide bodies such as the United Nations and national, provincial and local governments are getting involved. As individuals, we can encourage their positive actions and mirror this positive attitude in our own lives. And maybe you can ask your students to consider their own actions.

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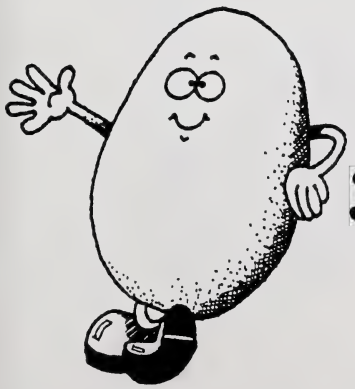

3. SUPPLEMENTARY RESOURCES

VIDEOS AND FILMS

Energy Efficiency Branch
Audiovisual Library
2nd Floor, 10010 - 106 Street
Edmonton, Alberta T5J 3L8
Phone: Dial 0 and ask for Zenith 22339 (in Edmonton, 427-5200)

Terms of Loan - No charge to borrow. Loan period of 3 days, maximum of 3 titles per loan. Energy Efficiency Branch will pay courier costs to you, you must return by courier and cover this cost.

Design with the Sun - Bullfrog Films, Video (produced 1979), 28 minutes, RE.2 BULL/3. Covers critical factors in solar design such as climate, siting, orientation to the sun and wind, thermal mass and insulation. Construction techniques are discussed.

Harness the Wind - National Film Board, Video (produced 1978), 12 minutes, RE.3 NFB. A non-technical introduction to windpower. Examines different types and styles of windmills.

Letting the Sun Shine In (ACCESS New Home Series) - ACCESS, Video (produced 1983), 30 minutes, NH.1 ACC/6. Discusses the feasibility of passive solar space heating. Tells how to plan a new home to take advantage of the sun. Mentions construction details that allow more efficient use of the sun's energy.

Lovins on the Soft Path - Bullfrog Films, Video (produced 1982), 36 minutes, RE.1 BULL. Amory and Hunter Lovins present the argument for planning a future self-sufficient in renewable energy. Looks at the technical, economic and political feasibility of a future reliant on renewable energy. Introduces the concepts of "hard" and "soft" energy paths.

Solar Energy: Towards the Sun (Nature of Things) - National Film Board/CBC, Video (produced 1978), 28 minutes, RE.2 NFB/1. Looks at passive solar residential design in Canada and experimental solar installations in the U.S., including large banks of photovoltaics, total energy systems producing hot water and electricity, and the "power tower" which focuses solar energy to produce high temperature heat.

The Solar House - National Film Board, Video (produced 1985), 11 minutes, RE.2 NFB/3. Reviews the principles of passive and active solar residential heating, including a discussion of thermal mass, thermal storage, overhangs, venting and distribution systems.

National Film Board
Room 120
9700 Jasper Avenue
Edmonton, Alberta T5J 4C3
Phone: 495-3010

Class Project: The Garbage Movie - National Film Board, 1980, colour, 23 minutes. A group of students, aged 8-13, start off on a school project to find out all they can about garbage, its composition, its disposal and the impact of its disposal on the environment. The places they visit tell us a lot about the society we live in, and about ecology, cities, art and history. Most important of all, students learn that what we do today has an impact on what happens tomorrow. Support material available.

Conserving for Tomorrow Series - An audio-visual series on conservation issues.
Building a Conserver Society
To Consume or to Conserve?
Agriculture in Crisis

Tilt - National Film Board, colour 16 mm film, 19 minutes. An animated film showing what is wrong with our world and how global co-operation might ease many of the world's ills. Co-produced by National Film Board and the World Bank. (Awards: Atlanta; Columbus).

Trees of Hope - 1985, colour 16 mm film, 18 minutes, Catalogue #1060 0185 093. Film provides a different viewpoint on wood as an energy source. Discusses the difficulties of obtaining wood, other energy sources available and steps being taken to conserve wood and forests.

Alberta Special Waste Management Corporation

Our Throwaway Society - Video to borrow, 25 min. 900 - 10909 Jasper Avenue, Edmonton, Alberta T5J 3L9 (422-5029).

All Alberta Jr. and Sr. High School Libraries

Water in Alberta: The Living Flow - Alberta Environment and Access Network colour video in two 30 minute segments. A copy of this video has been sent to all the Jr. and Sr. High Schools in the province by Alberta Environment.
Part 1 - Interconnections
Part 2 - Complexities
Describes the five natural water basins in Alberta and the underground water systems. The video deals with water usage, waste removal, natural river purifying, water treatment plant purifying, contaminates, charting water flows and usage, monitoring water flows and usage, and industrial and urban water problems.

Canadian Peace Congress - 300 Bathurst Street, Toronto, Ontario, M5T 2S3, (416) 868-6570

Warning! Warning! - eyewitness videotape of Chernobyl catastrophe

CBC Enterprises - Box 500, Station A, Toronto, Ontario M5W 1E6 (416) 975-3500

Wonderstruck: Environment Alert
The Journal: The Greenhouse Effect
The Journal: Looting A Legacy

CBC Radio - Box 500, Station A, Toronto, ON M5W 1E6

David Suzuki's Matter of Survival series - audio tapes $10 each or series of 5 for $45. Cheques payable to CBC Radio.

City of Edmonton, Environmental Services - 3rd Floor, 9803 - 102A Avenue, Edmonton, Alberta T5J 3A3, 496-5633 Attention: Tarra Kongsrude.

- recycling videos, gr. 1-6 and gr. 5+

Environment Council Library, Environment Council Library, Weber Centre, 5555 Calgary Trail, Edmonton, Alberta, phone 427-5793.

One Man's Garbage, Another Man's Gold - Video, 15 minutes.

Petroleum Resources Communication Foundation, 1250, 633 - 6 Ave. S.W., Calgary, AB T2P 2Y5.

Alaska Oil Spill - The Veco Response - describes the clean-up of the Exxon Valdez oil spill.
One Onion at a Time - shows the importance of finishing high school, and of taking math and science to lead to many careers in the petroleum industry.

Trans-Alta Utilities Corp. - 110 - 12 Ave. S. W., Box 1900, Calgary, Alberta
T2P 2M1 267-7459 (Cheryl Corbiell)

Acid Rain
Careers in the Electrical Industry

University of Alberta - Educational Media Services, Corbett Hall, 82 Ave. & 112 Street, Edmonton, Alberta T6G 2G4, 492-5039 (5040)

A Planet For The Taking - No. 1; Human Nature
The Journal: The Greenhouse Effect

TEACHING RESOURCES

The following is a list of educational materials suitable for teaching energy and resource conservation. Some of these resources are free and some have a cost. Please contact the supplier directly with your requests.

Alberta Energy, Energy Efficiency Branch, 2nd Floor, Highfield Place, 10010 - 106 St., Edmonton, AB T5J 3L8 427-5200 Fax 423-1474

Sunny Energy Saver Kit	(Grades 1/2)
The Glut Kit	(Grade 3)
Energy Matters...Use it Wisely	(Grade 4)
Catch the Spirit Kit	(Grade 5)
The Energy Sleuth Kit	(Grade 6)
The Energy News Kit	(Junior High)
The H.E.A.T. Kit	(Senior High)
Somebody Should **DO** Something About This	(K-12)

Alberta Environment, 9820-106 St., Edmonton, AB T5K 2J6 427-6310

The Environmental Fact Seekers' Guide
NIMBY (Not In My Backyard)
Snoop
Water Literacy Program (Units for Grades 4 - 12)

Alberta Forest Service, 10th Floor, 9920 - 108 St., Edmonton, AB T5K 2M4 427-3549. Forestry Exhibit Trailer, Alberta's Managed Forests. Travels to schools, contains 3-D dioramas of forest management practices, and a wide variety of interactive displays.

Alberta Tree Nursery and Horticulture Centre, Arbor Day program, R.R. #6, 17507 Fort Road, Edmonton, AB T5B 4K3, 422-1789

Bowman, M. L. and Coon, H. L., Recycling: Activities for the Classroom, ERIC Center for Science, Mathematics and Environmental Education, Columbus, Ohio.

City of Edmonton Environmental Services, Recycling Water and Waste Water, 3rd Floor, 9803 - 102A Avenue, Edmonton, AB T5J 3A3 496-5633 Attention: Tarra Kongsrude

Common Heritage Program, 200 Isabella Street, #300, Ottawa, Ontario K1S 1V7, (613) 235-7205.

CUSO, Education Department, Here to Stay - a Resource Kit on Environmentally Sustainable Development, 135 Rideau Street, Ottawa, Ontario K1N 9K7

Friends of Environmental Education Society of Alberta (FEESA), 641-21, 10405 Jasper Avenue, Edmonton, AB T5J 3S2, 427-6210

Adopt-a-Stream - Junior High
Aquatic Invertebrate Monitoring (AIM) Program - Junior/Senior High
Conservation Strategy Education Program - Available February 1991.
Fellowship in Environmental Education - Water Education Instruction
Northern Alberta Environmental Education Program

Fish and Wildlife Division, Alberta Forestry, Lands and Wildlife, Project Wild, Main Floor, 9945 - 108 Street, Edmonton, AB T5K 2G5.

Friends of the Earth, Rainforests: A Living Legend, 251 Laurier Avenue W., Suite 702, Ottawa, Ontario K1P 5J6 ($56)

Gardner, R. Save That Energy, Julian Messner, Division of Simon & Schuster Publishing Co., New York, N.Y.

General Motors, Sun Time, 7449 Melrose Avenue, Los Angeles, CA 90046 U.S.A.

Harper, D., Let's Use The Sun, Multiscience Publications - Canada Science Series, Montreal.

Jenkins, F. et al, Solar Energy: Solar Education for the 80s, J.M. Lebel Enterprises Ltd., Edmonton.

Knight, D., Harnessing the Sun: The Story of Solar Energy, William Morrow and Sons Inc., New York, New York.

Lai, E. and Schwalbe, M. (eds.), Science Activities for Young People, Canadian Stage and Arts Publications and Hummingbird Books, Toronto, Ontario.

Paper Chase Recycling, Recycling Programs, 11941 - 73 Street, Edmonton, AB T5B 1Z7 477-9391 Contact: Dennis Spelliscy (For Edmonton area schools only)

Petroleum Resources Communication Foundation, Our Petroleum Challenge, 3rd Edition, 1250, 633 - 6 Avenue S.W., Calgary, AB T2P 2Y5, Phone 264-6064, Fax 237-6286 ($)

Pollution Probe Foundation, The Acid Rain Primer, Pollution Probe Foundation, Toronto, Ontario, Canada.

Sierra Club, The Green Guides: An Educator's Guide to Free and Inexpensive Environmental Material, Environmental Education Committee, c/o Pat Suiter, P.O. Box 557953, Miami, FL 33255 ($)

Society, Environment & Energy Development Studies (SEEDS) Foundation, The Energy Literacy Series (includes Teacher Resource Book), Science Research Associates (Canada) Limited, Toronto.

Energy in the Future
Energy Systems
Energy Technologies
Renewable Sources of Energy

Trans-Alta Utilities, Community Relations, 110 - 12 Ave. S.W., Calgary, AB T2P 2M1 Call 267-7459 (Collect)

Alberta Wildflowers
From Coal to Kilowatts
Louie's Electricks
Trees - The Magnificent Creatures

POSTERS

Canadian Petroleum Association, Public Affairs Department, #1500, 633 - 6th Avenue S.W., Calgary, Alberta T2P 2Y5, 269-6721

"The Oil and Gas Story"

Educators for Peace and Social Justice, 1039 Royal Ave. S.W., Calgary, AB T2T 0L8, 278-8100 or 245-3038 ($)

"Earth"

Energy Efficiency Branch, 2nd Floor, 10010 - 106 Street, Edmonton, Alberta T5J 3L8, 427-5200.

"Conservation Farming"
"Soil Conservation"

New Scientist, Post Haste Direct Mail, Gemini House, 1a Brackley Road, Chiswick, London W4 2HN (Cheque/money order for £4.25)

"Ozone Screen Poster"

Petroleum Resources Communication Foundation, 1250, 633 - 6th Ave. S.W., Calgary, AB T2P 2Y5 Phone: 264-6064 Fax: 237-6286

"Service Rig Poster"

Syncrude, Public Affairs Division, P.O. Bag 4023, Fort McMurray, AB T9H 3H5 790-6403

"From Oil Sand to Synthetic Crude"

Transition Graphics: P.O. Box 2184, Salem, Oregon, U.S.A. 97308, (503) 364-0140 ($)

"Great Garbage Machine!"
"Buyer Beware?"
"Garbage Is What You Throw Away!"
"Running Out/Running Over!"
"Technology!"
"Why Recycle?"
"Recycling Is For Everyone!"
"Community Alert: Preparing For Energy Emergencies"

INFORMATION SERVICES

ECA Online (Computer Network) - a computerized conference, message service, and environmental information bulletin board. Parameters: 300-1200 baud, 8 data bits, 1 stop bit, no parity at 438-5793.

ENERGY MATTERS Inquiry Line - energy experts and a computer data bank provide information on how energy can be used wisely in the home. If you have any questions on anything related to home energy, DIAL "0", and ask for Zenith 22339 (Edmonton, 427-5300). You can also use ENERGY MATTERS line to find out about other residential services offered by the Energy Efficiency Branch.

Energy Efficiency Branch
Alberta Energy
2nd Floor, 10010 - 106 Street
EDMONTON, Alberta T5J 3L8
427-5200

BROCHURES

The following list of Brochures are free and available from the sources indicated. As they may not be available in class quantities, please contact the suppliers directly.

Alberta Energy, Energy Efficiency Branch, 2nd Floor Highfield Place, 10010 - 106 St., Edmonton, Alberta T5J 3L8.

- Attic Insulation
- Basement Insulation
- Caulking and Weatherstripping
- Condensation Concerns
- Geothermal Energy
- Heating System Maintenance
- Indoor Air Quality
- New Homes
- Passive Solar
- Photovoltaics
- Selecting a Heating System
- Ventilating Your Home
- Water and Electricity
- Windows
- Wood Heating

Alberta Energy, Scientific and Engineering Services and Research Division: Alberta Energy Information Centre, Main Floor, Bramalea Building, 9920 - 108 St., Edmonton, AB T5K 2M4.

- Geothermal Energy Resources in Alberta
- Measuring and Harnessing Alberta's Wind Resources
- Practical Methods to Seal and Insulate Residential Buidings
- Solar Energy Potential for Alberta
- Some Methods of Insulating Basements, Walls and Windows
- Alberta's Energy and Mineral Resources

Alberta Environment, The Recycle News, Pollution Control Division, Edmonton, Alberta, 427-5868

Alberta Environment, Communications Branch, Oxbridge Place, 9820 - 106 Street, Edmonton, Alberta T5K 2J6, 427-5870

- Conserving Water
- Recycling in Alberta

Alberta Special Waste Management Corporation, #900, 10909 Jasper Avenue, Edmonton, Alberta T5J 3L9, 422-5029 or 1-800-272-8873

British Petroleum Company, BP Statistical Review of World Energy, B.P. Educational Service, P.O. Box 30, Blacknest Road, Alton, Hampshire GU34 4PV

Canadian Nuclear Association, 111 Elizabeth Street, 11th Floor, Toronto, Ontario M5G 9Z9.

- Fusion: Energy For The Future,
- Nuclear Facts,
- Nuclear Energy in Canada: The CANDU System.

Canadian Petroleum Association, Environmental Issues: An Overview, Public Affairs Department, #1500, 633 - 6th Avenue S.W., Calgary, Alberta T2P 2Y5, 269-6721

Career Programs and Resources Branch, Occupational Profiles, Alberta Career Development and Employment, 10924 - 119 Street, Edmonton, Alberta, T5K 3P5 422-1794

City of Edmonton, Environmental Services, 3rd Floor, 9803 - 102A Ave., Edmonton, AB T5J 3A3 496-5633 Attention: Tarra Kongsrude.

Brochures available on water, waste water, recycling and waste management.

Clean Air Strategy for Alberta, Bag One, Mail Room, Main Floor, North Tower, Petroleum Plaza, 9945 - 108 Street, Edmonton, Alberta T5K 2G6 427-9793.

Factsheets available on: Greenhouse Effect, Acid Deposition (Acid Rain), Ozone, CGCs, etc.

The Coal Association of Canada, Coal in Canada, #301, 1000 Eighth Avenue S.W., Calgary, Alberta.

Energy, Mines and Resources Canada, Communications, Room 828, Distribution, 580 Booth Street, Ottawa, Ontario. K1A 0E4

Energy Supply and Demand:
- Canadian Oil Sands - Canadian Energy
- Natural Gas: An Alternative Transportation Fuel
- Solar Heating in Canada
- Working the Offshore Safely

R-2000 Technical Report Summary:
- Solar Water Heaters - A Buyer's Guide

Energy Efficient Home Design:
- Choosing an Energy-Efficient House: A Buyer's Guide
- Energy-Efficient Housing Construction (CMHC)
- Hotcan - New Home Energy Analysis Service

Other:
- 1987 Fuel Consumption Guide
- Future Transportation Fuels:
  - Conventional Fuels
  - Electric and Hydrogen-Powered Transportation
  - Alcohol Fuels
  - Gaseous Fuels
  - Synthetic Fuels
  - Renewable Energy - The Canadian Option

Environment Council of Alberta - Alberta Conservation Strategy, 8th Floor, 5555 Calgary Trail, Edmonton, Alberta, T6H 5P9, 427-5792.

- Environment by Design
- Municipal Solid Waste - Alberta's Untapped Resource?
- Reserves For Nature
- Resolving Conflict

Environmental Defense Fund, Protecting the Ozone Layer: What You Can Do, 257 Park Avenue South, New York, N. Y. 10010, (212) 505-2100.

Friends of the Earth, 53 Queen Street, #16, Ottawa, Ontario, K1P 5C5

Rainforest Rescue Campaign
Is the Grass Really Greener...?
Ozone Protection Campaign

Ontario Ministry of Energy, Turn on the Sun, (Revised Edition), Toronto.

Passmore, J. and Jackson, R., Renewable Energy: Innovation in Action, The Publications Office, Science Council of Canada, 100 Metcalfe Street, Ottawa, Ontario.

Pollution Probe, Facts on Solar Energy, 12 Madison Avenue, Toronto.

Robertson, E.E., Bioconversion: Fuels from Biomass, Biomass Energy Institute, Winnipeg.

Sustainable Agriculture Association, Box 1063, Nanton, Alberta, T0L 1R0 646-5752

TransAlta Utilities Marketing Services, Box 1900, Calgary, Alberta.

An Introduction to Wind Power
More Power to You

GUEST SPEAKERS

The following organizations may be able to provide a guest speaker for your class or school.

Alberta Forestry Association ($)
101 Alberta Block
10526 Jasper Avenue
Edmonton, Alberta T5J 1Z7
428-7582
(for $25.00 resource instructor will come with A/V)

Alberta Special Waste Management Corporation
#900, 10909 Jasper Avenue
Edmonton, Alberta
T5J 3L9
422-5029 or 1-800-272-8873

Calgary Rainforest Action Group
Calgary, Alberta
275-0247

Canadian Crossroads International
Western Regional Office
#101, 10920 - 88 Avenue
Edmonton, Alberta
T6G 0Z1
433-8015

Canadian Nuclear Association
111 Elizabeth Street
Toronto, Ontario M5P 1Z8
l-800-387-4477
(Would prefer schools get together for large presentations)

Canadian Wind Energy Association (CanWEA)
44A Clarey Avenue
Ottawa, Ontario
(613) 236-WIND

City of Edmonton (Edmonton schools only)
Environmental Services
3rd Floor, 9803 - 102A Avenue
Edmonton, Alberta T5J 3A3
496-5633
Attention: Tarra Kongsrude

Edmonton Recycling Society
11631 - 80 St.
Edmonton, Alberta T5B 2N3
471-0071

Environmental Resource Centre
10511 Saskatchewan Drive
Edmonton, Alberta T6E 4S1
433-4808
(for Edmonton area schools only)

Paper Chase Recycling
11941 - 73 Street
Edmonton, Alberta T5B 1Z7
477-9391
(Contact: Dennis Spelliscy
for Edmonton area schools only)

Petroleum Resources Communication Foundation
2030, 801 - 6th Avenue, S.W.
Calgary, Alberta T2P 3W2
264-6064 Fax: 237-6286

SEEDS (Society, Environment & Energy Development Studies) Foundation
#440, 10169 - 104 Street
Edmonton, Alberta T5J 1A5
(403) 424-0971

Small Power Producers Association of Alberta (SPPAA)
Orrin E. Hart, Chairman
Box 59
Claresholm, Alberta T0L 0T0

Solar Energy Society of Canada Inc.
Calgary Chapter
#229, 640 - 5th Avenue S.W.
Calgary, Alberta T2P 0M6
(403) 265-9439

"Stepping Stones" Program
Alberta Women's Secretariat
Education and Communications Division
8th floor Kensington Place
10011 - 109 Street
Edmonton, Alberta
(403) 422-5074

Trans-Alta Utilities Corporation
110 - 12th Avenue S.W.
Calgary, Alberta T2P 2M1
(403) 267-7459 (Cheryl Corbiell)

University of Alberta International Centre
Program Office
Edmonton, Alberta
492-2962

University of Calgary, Division of International Development
University of Calgary
Calgary, Alberta
220-7056

SPECIAL INTEREST GROUPS - for Teachers

The following organizations all have a conservation, energy and/or environment mandate. They can provide information, resources and services for you. What is available from each organization is designated in the **RESOURCES** column. Whenever there is a cost associated with an item, a ($) sign is indicated. All of these organizations have been contacted to ensure their cooperation with Alberta teachers. Please contact the organization directly to obtain details of existing policies.

ORGANIZATION	RESOURCES
Alberta Fish & Wildlife Department of Forestry, Lands & Wildlife Conservation Education Branch 9945 - 108 Street Edmonton, Alberta T5K 2G6 427-6757	- variety of educational materials - "Project Wild" teaching kit
Alberta Forestry Association 101 Alberta Block 10526 Jasper Avenue Edmonton, Alberta T5J 1Z7 428-7582	- "Forever a Tree" teaching kit ($) - Volunteers accepted - Resource Instructor visits ($) - Teacher/Library magazine
Alberta Wilderness Association ($) P.O. Box 6398, Station "D" Calgary, Alberta T2P 2E1 283-2025 **OR** office located at: 455 - 12 Street N.W., Calgary, AB T2N 1Y9	- Resources for Teachers only - Focus on wildlife/land use/wilderness/forestry - Student memberships ($) - Newsletter for members
Bennett Environmental Education Centre Edmonton Public Schools 9703 - 94 Street Edmonton, Alberta T6C 3W1 468-1439	- Available to Edmonton teachers only - Focus on weather/environment - Resources for teachers only
Calgary Zoo ($) Botanical Gardens and Prehistoric Park P.O. Box 3036, Station "B" Calgary, Alberta T2M 4R8 265-9310 **OR** Zoo located at: 1300 Zoo Road N.E., Calgary, AB	- many special activities - conservation oriented field trip programs during school year. - members accepted into zoological society ($) - Quarterly magazine with membership
Canadian Coalition on Acid Rain 112 Street St. Clair Avenue W., Suite 401 Toronto, Ontario M4V 2Y3	- Information packages - Encourages formation of support groups

Canadian International
Development Agency (CIDA)
P.O. Box 1310, Postal Station B
Hull, Quebec J8X 9Z9

- Audio-visual and print resources

Canadian Nuclear Association
111 Elizabeth Street
Toronto, Ontario M5P 1Z8
1-800-387-4477

- Information available
- Sponsor Science Fair award
- Can provide in-class presenters depending on numbers or presentations.

Canadian Water Resources Association ($)
Alberta Branch
48 Baker Crescent, N.W.
Calgary, Alberta T2L 1R4
282-0405

- Information referral service
- Memberships ($)
- Newsletter with membership

Canadians for Responsible Northern Development
11911 University Avenue
Edmonton, Alberta T6G 1Z6
436-4913

- Information for teachers
- Memberships ($)
- Newsletter with membership

Earth Island Institute ($)
300 Broadway, Ste. 28
San Francisco, CA 94113 U.S.A.
(415) 788-3666

- Student memberships ($)
- News magazine for members
- Volunteers accepted for projects

Edmonton Recycling Society
11631 - 80 Street
Edmonton, Alberta T5B 2N3
471-0071

- Volunteers accepted
- "Blue Box" curbside recycling
- Will send speakers

Educators for Social Responsibility
23 Garden Street
Cambridge, MA 02138 U.S.A.
(617) 492-1764

- Memberships ($)
- Information publications
- Newsletter with membership
- Short teaching units available

Energy Probe Research Foundation
225 Brunswick Avenue
Toronto, Ontario M5S 2M6
(416) 978-7014

- Members accepted
- Newsletter

Environment Council of Alberta
8th Floor, Weber Centre
5555 Calgary Trail, Southbound
Edmonton, Alberta T6H 5P9
427-5792

- Free informative publications
- Information on involvement in public hearings
- Computerized network

Environment Week Association
642-21, 10405 Jasper Avenue
Edmonton, Alberta T5J 3S2
427-6310

- Teacher/School memberships ($)
- One free newsletter per school
- Referral to many different youth oriented activities from many organizations.

Environmental and Outdoor Education Council
Alberta Teachers' Association
Barnett House
11010 - 142 Street
Edmonton, Alberta T5N 2R1
453-2411

- Memberships ($)
- Newsletter and journal
- Annual conference
- Travelling library

Environmental Resource Centre
10511 Saskatchewan Drive
Edmonton, Alberta T6E 4S1
433-4808

- Resources available on environmental issues
- Information on site
- Speakers available

Ft. McMurray Oil Sands Interpretive Centre
515 MacKenzie Blvd.
Ft. McMurray, Alberta T9H 4X3
743-7166

- Hands-on activities
- Information packages
- Videos for loan
- Field trips

Friends of the Earth ($)
Suite 701, 251 Laurier Avenue W.
Ottawa, Ontario K1P 5J6
(613) 230-3352

- Teaching resources and audio-visuals
- Regular and student memberships ($)
- Newsletter with membership

Friends of the Environment
contact your local branch of
Canada Trust, or the Harmony
Foundation, P.O. Box 4016, Station
C, Ottawa, Ontario K1Y 4P2

- funding for local environmental projects

Friends of Environmental Education Society of Alberta (FEESA)
641-21, 1045 Jasper Avenue
Edmonton, AB T5J 3S2
427-6210

- Teacher memberships ($)
- Newsletter
- Teaching kits ($)

Green Teacher
95 Robert Street
Toronto, Ontario M5S 2K5
(416) 960-1244

- Energy issues/ecology materials for classroom
- Magazine ($)

Greenpeace Foundation ($)
1711B - 16 Street N.W.
Calgary, Alberta T2M 3P1
261-4828
OR 10511 Saskatchewan Drive
Edmonton, Alberta T6E 2S1
433-4808

- Resource material
- Regular and student memberships ($)
- Magazine with membership
- Speakers' bureau
- Videos

Guardian of the Rainforest
World Wildlife Fund
Suite 201, 60 St. Clair Avenue East
Toronto, Ontario M4T 1N5
(416) 923-8173

- Memberships ($)
- Newsletter with membership
- Grade 4-8 science teaching kit

Imagination Market
10215 - 112 Street
Edmonton, AB T5K 1M7
426-1862

- Educational workshops
- Retail & mail order of recycled & reusable materials

John Janzen Nature Centre
P.O. Box 2359
Edmonton, Alberta T5J 2R7
434-7446

- Contact staff for nature information
- Visit programs
- Library
- located at Fort Edmonton Park

Junior Forest Rangers and Wardens
10th Floor, Bramalea Building
9920 - 108 Street
Edmonton, Alberta T5K 2M4
427-2545

- Programs in forestry/ecology/woods travel/leadership ($)
- Student members are basis of organization
- Regional newsletters
- Activities for ages 6-18

Kananaskis Young Scientists' Project
c/o The University of Calgary
Kananaskis Centre for Env. Research
Seebe, Alberta T0L 1X0
220-5355, 673-3662

- 2/3/4 day field trips (teacher must initiate)
- Student journals
- Teacher planning and field trip manuals

Learner Centres

- Memberships
- Teaching resources
- Guest speakers
- Films, videos

Arusha International Development Resource Centre
233 - 10 Street N. W.
Calgary, Alberta T2N 1V5
270-3200

Barbara Ward Centre
P.O. Box 3190
St. Paul, AB T0A 3A0
645-2454

Camrose International Institute
4802 - 49 Avenue
Camrose, AB T4V 0M7
672-8780

World Citizen's Learner Centre
1011 - 4 Avenue S.
Lethbridge, AB T1J 0P7
328-5725

Development Education Coordinating Council of Alberta
211, 223 - 12 Avenue S.W.
Calgary, AB T2R 0G9
269-4744

National Science Teachers Association ($)
Energy & Education Special Projects
5112 Berwyn Road, 3rd Floor
College Park, MD 20740 U.S.A.
(301) 220-0874

- Instruction packets
- Newsletter ($)

Natural Areas Steward Program
4th Floor, South Tower
9915 - 108 Street
Edmonton, Alberta T5K 2C9
427-5209

- Student memberships
- Newsletter

Nuclear Awareness Project
Box 2331
Oshawa, Ontario L1H 7V4
(416) 725-1565

- Teaching resources ($)
- Audio-visual programs
- Memberships

Outdoors Unlittered ($)
#45, 9912 - 106 Street
Edmonton, Alberta T5K 1C5
429-0517

- Information kits to all schools regarding "Pitch-In" campaign
- School memberships ($)
- Newsletter to all schools

Pollution Probe Foundation ($)
12 Madison Avenue
Toronto, Ontario M5R 2S1
(416) 926-1907

- Resource material
- Memberships ($)
- Magazine
- Newsletter

Recyling Branch
Alberta Environment
5th flr, 9820 - 106 Street
Edmonton, AB T5K 2J6
427-5838

- Lists of local recycling programs

Recycling Council of Alberta ($)
P.O. Box 101, 2938 - 11 Street N.E.
Calgary, Alberta T2E 7L7
262-4542

- Student memberships ($)
- Newsletter
- Volunteer programs

Renew America
Suite 719,1001 Connecticut Avenue, N.W.
Washington, D.C. 20036 U.S.A.
(202) 466-6880

- Publications ($)
- Memberships ($)
- Quarterly report with membership

SEEDS Foundation
(Society, Environment & Energy Development Studies)
#440, 10169 - 104 Street
Edmonton, Alberta T5J 1A5
424-0971

- Newsletter for teachers
- Energy Literacy series from workshops or by direct purchase
- Teacher's guides and student books for nonrenewables, renewables, and electrical sources ($)

Toxics Watch
10511 Saskatchewan Drive
Edmonton, Alberta T6E 4S1
433-8711

- Memberships ($)
- Volunteers welcome
- Resources available to everyone

VIDEA (Victoria International Development Education Association)
407 - 620 View Street
Victoria, B.C. V8W 1J6
(604) 385-3315

- Newsletter
- Books
- Videos

SPECIAL INTEREST GROUPS - for Students

The following is a list of organizations that you can become involved with as part of your personal commitment to conservation and environmental protection. Any services having a fee associated with them are designated with a ($) sign. Contact the group or groups that interest you to find out more about their activities, local chapters and how you can get involved.

ORGANIZATION	RESOURCES
Alberta Forestry Association ($) 101 Alberta Block, 10526 Jasper Avenue Edmonton, Alberta T5J 1Z7 428-7582	- Volunteers accepted
Calgary Zoo ($) Botanical Gardens and Prehistoric Park P.O. Box 3036, Station "B" Calgary, Alberta T2M 4R8 265-9310 **OR** Zoo located at: 1300 Zoo Road N.E., Calgary, AB	- Members accepted into zoological society ($) - Quarterly magazine with membership - Special activities
Canadian Coalition on Acid Rain 112 Street St. Clair Avenue W. Suite 401 Toronto, Ontario M4V 2Y3	- Information packages - Encourage formation of support groups
Camrose International Institute ($) 4802 - 49 Avenue Camrose, Alberta T4V 0M7 672-8780	- Student memberships ($) - Free newsletter
Canadian Water Resources Association ($) Alberta Branch 48 Baker Crescent, N.W. Calgary, Alberta T2L 1R4 282-0405	- Memberships ($) - Newsletter with membership
Earth Island Institute ($) 300 Broadway, Ste. 28 San Francisco, CA 94113 U.S.A. (415) 788-3666	- Student memberships ($) - Newsmagazine for members - Volunteers accepted for projects
Edmonton Recycling Society 11631 - 80 Street Edmonton, Alberta T5B 2N3 471-0071	- Volunteers accepted
Energy Probe Research Foundation 225 Brunswick Avenue Toronto, Ontario M5S 2M6 (416) 978-7014	- Members accepted - Newsletter

Environmental Resource Centre
10511 Saskatchewan Drive
Edmonton, Alberta T6E 4S1
433-4808

- Resources available on environmental issues
- Information on site

4-H Branch
Rural Services Division,
Alberta Agriculture
7000 - 113 Street
Edmonton, Alberta T6H 5T6
427-2541

- For ages 10-21
- For members only:
  - information, newsletter, activities

Projects include Conservation Camp, Highway Clean-up, Outdoorsman Project, Wildlife Habitat Project

Friends of the Earth
Suite 701, 251 Laurier Avenue West
Ottawa, Ontario K1P 5J6
(613) 230-3352

- Student memberships
- Newsletter with membership

Greenpeace Foundation ($)
Basement, 223 - 12 Avenue S.W.
Calgary, Alberta T2R 0G9
261-4828
OR 10511 Saskatchewan Drive
Edmonton, Alberta T6E 4S1
433-4808

- Student memberships ($)
- Magazine with membership

Guardian of the Rainforest
World Wildlife Fund
Suite 201, 60 St. Clair Avenue East
Toronto, Ontario M4T 1N5
(416) 923-8173

- Memberships ($)
- Newsletter with membership

John Janzen Nature Centre
P.O. Box 2359
Edmonton, Alberta T5J 2R7
434-7446
OR located at:
Fort Edmonton Park, Fox Drive

- Contact staff for nature information
- Visit programs
- Library

Junior Forest Rangers and Wardens
10th Floor, Bramalea Building
9920 - 108 Street
Edmonton, Alberta T5K 2M4
427-2545

- Programs in forestry/ecology/ woods travel/leadership ($)
- Student members are basis of organization
- Regional newsletters
- Activities for ages 6-18
- Pathfinders (6-9) - Trailblazers (9-12)
- Adventurers (12-15)
- Challengers (15-18)

Kids Against Pollution (KAP)
275 High Street
Closter, N.J. U.S.A. 07624
(201) 768-1332

- involves students in letter-writing campaigns and community-based activities.

Natural Areas Steward Program
4th Floor, South Tower
9915 - 108 Street
Edmonton, Alberta T5K 2C9
427-5209

- Student memberships
- Newsletter

Outdoors Unlittered ($)
#45, 9912 - 106 Street
Edmonton, Alberta T5K 1C5
429-0517

- School memberships ($)
- Newsletter to all schools

Pollution Probe Foundation ($)
12 Madison Avenue
Toronto, Ontario M5R 2S1
(416) 926-1907

- Resource material
- Memberships ($)
- Magazine
- Newsletter

Recycling Council of Alberta ($)
P.O. Box 101, 2938 - 11 Street N.E.
Calgary, Alberta T2E 7L7
262-4542

- Student memberships ($)
- Newsletter
- Volunteer programs

Students Against Nuclear
Energy (S.A.N.E.)
Kari-Ann Kuperis
2908 - 17 Street S.E.
Calgary, AB T2G 3W3

- Student memberships

Toxics Watch
10511 Saskatchewan Drive
Edmonton, Alberta T6E 4S1
433-8711

- Memberships ($)
- Volunteers welcome
- Resources available to everyone

SPECIAL EVENTS

The groups listed below coordinate spescial events and conduct them annually. Please contact them directly for more information.

Agriculture Week
in the month of March
Alberta Agriculture
427-2127

Consumer Week
in the month of October
Consumers' Association of Canada
426-3270

Earth Day
in the month of April
Earth Day Canada Headquarters
Victoria, B.C.
Ph. (604) 382-1990
Fax. (604) 382-1660

Education Week
April or May
Communications Branch
Alberta Education
427-2285

Energy Awareness Week
in the month of November
Energy Conservation Branch
427-5200

Environment Week
in the month of June
Environment Week Association
426-4191

Forestry Week
in the month of May
Alberta Forestry Service
Alberta Forestry Lands and Wildlife
427-6233

Pitch-In Week
in the month of May
Outdoors Unlittered
429-0517

Soil Conservation Week
in the month of April
Soil Conservation branch
Alberta Agriculture
422-4385

Wildlife Week
in the month of April
Fish and Wildlife Division
Alberta Forestry,
Lands and Wildlife
427-6757

World Food Day
in the month of October
World Food Day Committee
429-0766

FIELD TRIP CENTRES

The following is a list of centres that provide a hands-on experience for students in an aspect of energy conservation or resource conservation. Contact should be made directly with the centre to obtain details of what is offered to school groups or students.

Alberta Forest Service Museum
Forest Technology School
1176 Switzer Drive
Hinton, Alberta T0E 1B0
865-8211

Alberta Tree Nursery and Horticulture Centre
R.R. #6, 17507 Fort Road
Edmonton, Alberta T5B 4K3
Telephone: 422-1789 (in Edmonton)
198-5272 (toll-free through any government R.I.T.E. Operator - check your local telephone directory under "Government of Alberta").

Bennett Environmental Education Centre
Edmonton Public Schools
9703 - 94 Street
Edmonton, Alberta T6C 3W1
468-1439

Calgary Zoo
Botanical Gardens and Prehistoric Park
P.O. Box 3036, Station "B"
Calgary, Alberta T2M 4R8
265-9310
OR Zoo located at:
1300 Zoo Road N.E., Calgary, AB

City of Edmonton
Environmental Services
3rd floor, 9803 - 102A Avenue
Edmonton, Alberta T5J 3A3
496-5633
Attention: Tarra Kongsrude
For Edmonton schools only; tours of the Water Treatment Plant, Waste Water Plant, and Landfill

Devonian Botanic Garden
University of Alberta
Edmonton, Alberta T6G 2E1
987-3054
OR located at:
Hwy 60, 15 km. south of Hwy 16

Environmental Resource Centre
10511 Saskatchewan Drive
Edmonton, Alberta T6E 4S1
433-4808

Energeum
(Energy Resources Conservation Board)
640 - 5th Avenue S.W.
Calgary, Alberta T2P 3G4
297-4293

Fort Calgary Preservation Society
P.O. Box 2100, Station "M", #106
Calgary, Alberta T2P 2M5
290-1875
OR office located at:
750 - 9th Avenue S.E., Calgary, AB

Ft. McMurray Oil Sands Interpretive Centre
515 MacKenzie Blvd.
Ft. McMurray, Alberta T9H 4X3
743-7167

Glenbow Museum
130 - 9th Avenue S.E.
Calgary, Alberta T2G 0P3
264-8300

John Janzen Nature Centre
P.O. Box 2359
Edmonton, Alberta T5J 2R7
434-7446
OR located at Fort Edmonton Park, Fox Drive, Edmonton

Kimiwan Lake & Wildlife Preservation Society
P.O. Box 606
McLennan, Alberta T0H 2L0
324-3053

Lethbridge Naturalist Society
P.O. Box 1691
Lethbridge, Alberta T1J 4K4
328-2870

Lethbridge Wind Research Test Site
Alberta Agriculture
Agriculture Centre
Lethbridge, Alberta T1J 4C7
381-5515
Attention: B. Paterson

Paper Chase Recycling
11941 - 73 Street
Edmonton, Alberta T5B 1Z7
477-9391
Attention: Dennis Spelliscy
(for Edmonton Area Schools only)

Provincial Museum of Alberta
12845 - 102 Avenue
Edmonton, Alberta
427-1730

Rocky Mountain YMCA
(Yamnuska Centre)
Seebe, Alberta T0L 1X0
673-3858

Shannon Terrace Environmental Education Centre
c/o Fish Creek Provincial Park
Alberta Recreation & Parks
P.O. Box 2780
Calgary, Alberta T2P 0Y8
297-7827

Strathcona Wilderness Centre
Strathcona County Recreation & Parks Deptartment
2025 Oak Street
Sherwood Park, Alberta T8A 0W9
922-3939
OR located at Baseline Rd & Range Rd. 212, Strathcona County

Tyrrell Museum of Paleontology
Box 7500
Drumheller, Alberta T0S 0Y0
823-7707

Y.W.C.A. (Ya Wo Ch As Centre)
Box 313
Fallis, Alberta T0E 0V0
646-5752
OR located at Lake Wabamun, Alberta

ALBERTA PROVINCIAL PARKS

The Alberta provincial park service has an environmental conservation program to give students a hands-on experience in a wildlife habitat. Learning Resource Manuals are available for class visits to the parks from the Centre for Education in Edmonton, telephone 429-8000 and at the Calgary Board of Education Office in Calgary, telephone 294-8205. The Manuals are also available from:

Brian Ogston
Environment Education Co-ordinator
Alberta Recreation and Parks
16th Floor, Standard Life Centre
10405 Jasper Avenue, Edmonton, Alberta T5J 3N4
Telephone: 427-9429

Specific Learning Resource Manuals are written for the following parks:

Cooking Lake - Blackfoot Park
Cypress Hill Park
Dinosaur Park
Kananaskis Country Parks
Lesser Slave/Hillard's Bay Parks
Miquelon Lake Park
Writing-on-Stone Park

The Standard Learning Resource Manual is available for use with specific Park Chapters relating to the following parks:

Big Hill Springs
Carson Pegasus
Cold Lake
Crimson Lake
Cross Lake
Gregoire Lake
Long Lake
Midland
Moonshine Lake
Pembina River
Pigeon Lake
Queen Elizabeth
Red Lodge
Saskatoon Island
Sir Winston Churchill
Thunder Lake
Vermilion
Wabamun Lake
William A. Switzer
Winagami
Young's Point

CLASSROOM MATERIAL SUPPLIERS

The following list is of companies that supply educational materials in energy and environmental areas. All these companies have catalogues available upon request.

Crystal Productions Co.
Box 2159
Glenview, Illinois 60025
U.S.A.

Fisher Scientific Co.
10720 - 170 Street
Edmonton, Alberta T5S 1J3

Hawkhill Associates, Inc.
P.O. Box 1029
Madison, Wisconsin 53701
U.S.A.

Hubbard Scientific Co.
P.O. Box 104
Northbrook, Illinois 60065
U.S.A.

Imagination Market
10215 - 112 Street
Edmonton, Alberta
T5K 1M7
426-1862

Spectrum Educational Supplies Limited
125 Mary Street
Aurora, Ontario L4G 1G3

TECHNICAL REPORTS

The following list of technical reports may provide you with more detail on energy and conservation projects.

Alberta Agriculture, 1987 Reprint, Low Energy Home Designs, Alberta Agriculture Print Media Branch, 7000 - 113 Street, Edmonton, Alberta T6H 5T6.

American Section of the International Solar Energy Society, 1976, Sharing the Sun! Solar Technology in the Seventies, Ed. K.W. Boer, 10 Volumes, 300 State Road 401, Cape Canaveral, Florida, U.S.A., 32920.

Calhoun, Elizabeth, 1983, 20 Simple Solar Projects, Rodale Press, Emmaus, Pennsylvania.

Energy Resources Conservation Board, 1987, Energy Alberta 1987, Energy Resources Conservation Board Head Office, 640 - 5th Avenue S.W., Calgary, Alberta T2P 3G4.

McCallum, Bruce, 1979, Environmentally Appropriate Technology: Renewable Energy and Other Developing Technologies for a Conserver Society in Canada (4th Edition), Office of the Science Advisor - Fisheries and Environment Canada, Ottawa.

Nova Scotia Department of Mines & Energy, 1981, One Hundred and One Solar Energy Projects, Halifax, Nova Scotia.

RECOMMENDED READINGS

The following resources would make excellent additions to your school or personal library.

Alberta Energy, Energy Efficiency Branch, 2nd flr, 10010 - 106 St., Edmonton, AB T5J 3L8

Passive Solar Information Package
Photovaltaics Information Package
Wind Power Information Package

Bott, Robert, Brooks, David and Robinson, John, 1983, Life After Oil: A Renewable Energy Policy for Canada, Hurtig Publishers Ltd., Edmonton.

Brown, L.R., 1981, Building a Sustainable Society, Norton and Company, New York.

Brown, L.R., 1989, State of the World 1989, A Worldwatch Institute Report on Progress Toward a Sustainable Society, W.W. Norton, 1989.

Cordell, A.J., 1985, The Uneasy Eighties - The Transition to an Information Society, Science Council of Canada, Ottawa.

Dehr & Bazar, Good Planets are Hard to Find!, Earth Beat Press, 1989, Vancouver, B.C.

Earthworks Group, 50 Simple Things You Can Do to Save the Earth.

The Greenhouse Crisis Foundation, 101 Ways to Help Heal the Earth: A Citizen's Guide, The Greenhouse Crisis Foundation, 1990.

Gribbon, John, 1988, The Hole In The Sky, Bantam Books, Toronto.

Hardin, G. and Baden J. (eds.), 1977, Managing the Commons, W.H. Freeman and Company, San Francisco.

Harmony Foundation of Canada, Home & Family Guide: Practical Action for the Environment.

International Union for the Conservation of Nature and Natural Resources, 1980, World Conservation Strategy, IUCN, Gland, Switzerland.

Kelley, Kevin W. for the Association of Space Explorers, The Home Planet, Addison-Wesley Publishing Company, 1988.

Lovins, Armory B., 1977, Soft Energy Paths: Toward a Durable Peace, Harper Colophon Books, New York, N.Y.

Lovins, Amory B., and L. Hunter, and Zickerman, Seth, 1986, Energy Unbound: A Fable for America's Future, Sierra Club Books, San Francisco.

Meadows et al, 1972, The Limits to Growth, A Report for the Club of Rome's Project on the Predicament of Mankind, Universe Books, New York.

Mungall & McLaren, Planet Under Stress, Royal Society of Canada.

Myers, Dr. Norman (ed.), 1984, GAIA: An Atlas of Planet Management, Anchor Press/Doubleday & Comapny Inc., Garden City, New York.

Parliament of Canada, 1981, Energy Alternatives, Report of the Special Committee on Alternative Energy and Oil Substitution, Canadian Government Publishing Centre, Ottawa.

Pollution Probe, The Canadian Green Consumer Guide: How You Can Help, McLelland & Stewart, Toronto.

Science Council of Canada, 1977, Canada as a Conserver Society: Resource Uncertainties and the Need for New Technologies, Report No. 27, Ottawa.

Timberlake, Lloyd, 1987, Only One Earth: Living For The Future, B.B.C. Books, London, U.K.

Ward, Barbara, 1966, Spaceship Earth, Columbia University Press, New York.

World Commission on Environment and Development (The Brundtland Commission), 1987, Our Common Future, Oxford University Press, Oxford, U.K.